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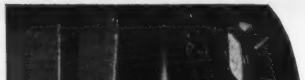

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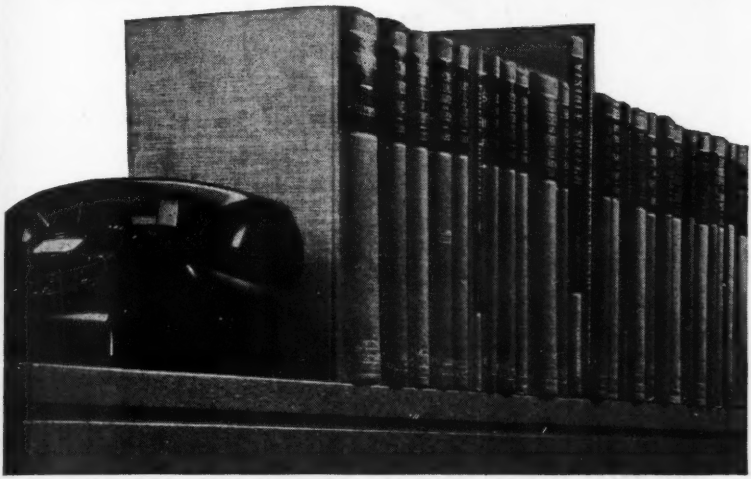

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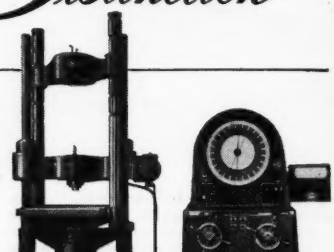

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Dr. Clinton R. Hanna

SCIENTIST-INVENTOR

His gun stabilizer revolutionized tank combat during World War II. He enrolled in Westinghouse Graduate Student Course right after graduation from Purdue University in 1922. He advanced rapidly to head of Development Division in 1930, manager of Electromechanics Department in 1937, and Associate Director of the Research Laboratories, his present position, in 1944.

Where human muscles and reflexes aren't quite up to the job, the electromechanical regulator can do it many times faster and more accurately. Proof of that is in the career of Dr. Clinton R. Hanna, who has developed a whole family of these devices in his 30 years with Westinghouse. It was his gyroscope-controlled gun stabilizer that during World War II enabled Allied tanks to fire accurately even when traveling over rough terrain, and helped swing the tide of battle against the enemy in Africa. When heavy seas sent ship-based radar antennas bobbing erratically, Dr. Hanna designed a system for stabilizing them in the roughest weather.

The soft-spoken, 51-year-old Westinghouse scientist has some 100 patents to his credit in the field of regulators. One of his earliest was a device for controlling the speed of steel mill roller motors. Strangely enough, it was this device which led a visiting Army officer to wonder if the same principle could be applied to stabilizing tank guns. Dr. Hanna thought it could and proceeded to prove it.

Quiet and methodical, the Westinghouse scientist likes to probe for new and difficult applications in his field, isn't swerved by the failure of previous searchers to come up with the right answers.

Dr. Hanna's latest achievement is the development of an automatic pilot with unlimited maneuverability.

These are but a few of the high lights in the career of "Clint" Hanna, adventurer in research. The larger picture should certainly include many other contributions, mainly those that have aided in the improvement of numerous Westinghouse products that feature electrical control and regulation. They make it abundantly clear that it is the know-how and experience of scientists like Dr. Hanna which are the cornerstones of industrial progress. Westinghouse Electric Corporation, Pittsburgh, Pennsylvania. G-10228-A

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W. R. Woolrich, President, A.S.E.E., 1952-53

About 45 years ago, the son of a retired Wisconsin pioneer dairyman made a bargain with the power plant people of Mineral Point.

He would work for nothing until he learned to operate the plant. And work he did, getting up at 4:30 every morning to fire the plant before school time.

On graduation from high school at 17, he was power engineer for a lead and zinc mining company. (Twenty years later he learned he had been too young to hold such a position because the state law at that time required power plant operators to be 21.)

But came the lightning-like depression of 1907 which claimed mining as one of its first victims. One day he shut down the plant, "laid it by," greased all the machinery, and drained the boilers. The next day he was on his way to Madison where he later received two University of Wisconsin degrees in engineering—mechanical and electrical.

That was the start of W. R. Woolrich, College of Engineering dean, Bureau of Engineering Research director, and professor of mechanical engineering at the University of Texas—and now president of the American Society for Engineering Education.

Dean Woolrich has had an interesting engineering career which includes work in industry, government and education—as a member of a team of engineering educators who helped organize an engineering college at DePaul University; Western Electric Company engineer and International Harvester Company work-shop school director; assistant professor, then professor and chairman of the mechanical engineering department at the University of Tennessee, and later head of the Tennessee Valley Authority's Agricultural Industries Division. He joined The University of Texas faculty in 1936.

Woolrich's TVA appointment came as a result of work he did with the late Dr. Harcourt Morgan, then University of Tennessee president, developing a program for interspersion of agriculture and industry on the western slopes of the Appalachian Mountains. The plan was incorporated in the Congressional act creating the TVA.

In other government work, Dean Woolrich served as director of a University of Tennessee student army training corps' trade school in World War I, regional advisor and representative in Texas, Louisiana and New Mexico for the U. S. Office of Education in World War II, and chief scientific officer for a U. S. mission to Great Britain in 1948–49 to survey that nation's industry and scientific facilities.

He has been an advisor to the Department of Commerce, and U. S. Government Patents Board, and U. S. representative on the British Fulbright Commission, administrators for the Congress created fellowships and scholarships involving Great Britain.

At the present, he is chairman of a National Research Council committee to improve housing in warmer climates of the U. S. and other parts of the world.

Dean Woolrich is very familiar with the American Society for Engineering Education's background, especially its teaching and research activities. He was president of the Engineering College Research Association in 1946–47 when it completed plans to merge with the Society for Promotion of Engineering Education to form the ASEE. Since then he has served as the ASEE's Southwest Section representative, chairman of its International Relations Committee and its representative on

W. R. WOOLRICH, PRESIDENT

the Engineering Council for Professional Development.

His activities with other professional engineering societies include being national chairman of the American Society of Mechanical Engineers' local sections' activities, and a director, and later vice-president of that organization; a director of the American Society of Refrigeration Engineers; twice chairman of the American Association for Advancement of Science's engineering section; on the National Society of Professional Engineers' educational committee; and, currently, chairman of the Texas Society of Professional Engineers' educational program.

He is the author of several handbooks and publications on engineering.

Although he has many national activities, Dean Woolrich has been diligent at home strengthening the reputation of the College of Engineering at The University of Texas. Standards have been raised, the number of credits necessary for graduation increased, an advisory system for engineering students installed and graduate level work greatly expanded for all engineering departments.

In Recognition and a Forward Look

By W. R. WOOLRICH

President of ASEE, Dean of Engineering, University of Texas

In the roster of associations of the several scientific and engineering professions of both Europe and America, the American Society of Engineering Education has the unique distinction of being the first and most effective organization within any of these professions established specifically to promote and develop improved methods of college and university teaching by the teachers and teaching administrators themselves. For nearly sixty years these college and university teachers of the engineering profession of North America have continued to make constructive and analytical studies of their own objectives, methods and procedures and also periodically to investigate the comparative methods and results of the engineering teaching of other nations.

Within the Society many of us have become so inured to the many activities of the organization that we fail to recognize the importance and the impact of this continuing program of the several Divisions, Sections, Committees, and Councils of the American Society for Engineering Education and its two predecessors from which it was created, viz., the Society for the Promotion of Engineering Education and the Engineering College Research Association. Each of us should pay tribute to this long line of distinguished, competent and devoted teachers of engineering who have made earnest and sacrificial life-time contributions to the art and science of engineering education in North America.

Each new administration that accepts the responsibility of serving the Society is fortunate indeed to inherit such a birthright. The bench marks have been well established from which to project the forward planning.

Some of the activities of committees nurtured by the Society are of a continuing nature and any change in administration should cause no disruption of their effective work in progress. Other functions of the ASEE are under the direction of committees which require annual or biennial changes of personnel by virtue of the authority through which they were created. To provide this change of personnel, yet maintain or increase the effectiveness of the group, is an obligation of the Administration of the Society.

Retiring President S. C. Hollister has recently named two very urgently needed Committees that were authorized by the Executive Board and Council, the one under the leadership of Dr. L. E. Grinter on "The Evaluation of Engineering Education" and the other now being organized under the Chairmanship of Dr. Richard B. Teare on "Improvements of Society Function." The work of these two committees is very essential to the future progress of the Society and their work should result in the development of a more closely knit organization in which all members participate.

Throughout the coming year, by utilizing the general framework of the appointed and established Committees, Sections, Divisions and Councils, may we make it our business to give a renewed emphasis to superior teaching. In the past decade of war years, it has been necessary for many of us to underscore creative research in our colleges and universities, and many of those who have

entered the engineering teaching profession during this ten or twelve year period have found the research enterprise of many departments receiving more recognition than the teaching of the engineering students. Research in itself should be one of the fountain sources of inspiration by which the teacher reinforces himself in his teaching preparation, and our research and administrative contributions should be maintained as complimentary to the major obligation of doing effective inspirational teaching and not in competition with it.

Very closely integrated with this goal of improving our classroom teaching is the timeliness of re-affirming our philosophy of engineering ethics by taking a strong position with the professional engineering societies in requesting them to join with us in pronouncing again the CANON OF ETHICS OF THE ENGINEER as the creed of the professional engineer. Under the disrupting influence of wars, cracks have developed in the moral integrity displayed by a few in our profession, especially in their engineer-contractor, engineer-architect, engineer-salesman or even engineer-client relationships. By its very nature, engineering cannot afford even microscopic cracks in its structure if it would build for a better profession of tomorrow. This administration will accept it as one of the duties of the office to obtain cooperation of the professional engineering societies in this re-emphasis on integrity in all channels of engineering enterprise, but a re-enforced front all along the line of our several committees and in our classrooms in which we again express a new zeal for plain honesty, forthrightness and morality will be most compensating.

To meet the urgent need that the universities provide North America and many other areas of the world with more engineers with top level, scientific education is a real challenge to all graduate level engineering colleges and universities. It should be a matter of deep concern to all of us in America that a disproportionate number of the best educated and trained engineers of the world came from European and British universities up to the advent of World War II. With the restoration of Europe, much of this leadership in advanced fundamental engineering science can be expected to be claimed again by the scientific educational centers of Western Europe if we of America cannot meet the need.

The future pattern of American engineering education will probably call for a large number of men with diplomas from the technical institutes, a somewhat smaller number who will reach the level of their best usefulness and service at the baccalaureate level, still a smaller select group who should receive instruction through the Master's level, then a highly selected group who should receive instruction by organized programs designed to carry men through the doctorate and post doctorate to possible levels far in excess of anything we have attempted on this side of the Atlantic to the present day. The building up of a very high level scientific and engineering educational system within North America for a selected portion of our capable candidates is even of greater importance than that we meet the growing deficiency in numbers of capable engineers at the baccalaureate grade.

Those who wrote the present Constitution of the American Society for Engineering Education were desirous of emphasizing that this was a society of engineering educators from the American Continent. From earliest days of the Society for the Promotion of Engineering Education the engineering teachers of Canada have been active participants. In fact, the Fifth Annual Meeting of the SPEE was held at the University of Toronto and the 39th at McGill University.

As a Society let us not overlook our great opportunity to establish closer bonds of professional fellowship with those teachers in our own profession in South America, Great Britain, Europe, and Asia. There is much evidence that the time is appropriate for us to invite closer cooperation in engineering education between the engineering schools of North America and those established in other

areas of the globe. We in North America have been the recipients of much of the scholarly work in science and engineering of Great Britain and Europe for over two hundred years. Some of the finest contributions made to engineering education in the United States came from our members who received their initial education and inspiration from British and European universities. In this as in other international relationships we will profit most by giving most.

Reserve this date . . . .

June 22-26, 1953

ANNUAL MEETING

UNIVERSITY OF FLORIDA

GAINESVILLE, FLORIDA

In the News

Eight members of the 24-member National Science Board of the **National Science Foundation** whose initial two-year terms expired on May 10, 1952, have been reappointed by the President for full six-year terms, ending May 10, 1958.

Following is a list of members of the Board receiving reappointments: Sophie D. Aberle, Special Research Director, University of New Mexico, Albuquerque, New Mexico; Robert P. Barnes, Head, Department of Chemistry, Howard University, Washington, D. C.; Chester I. Barnard, Chairman of the Board, and retiring President, Rockefeller Foundation, New York, N. Y.; Detlev W. Bronk, Chairman of the Executive Committee of the Board, President, The Johns Hopkins University, Baltimore, Maryland; Gerty T. Cori, Professor of Biological Chemistry, School of Medicine, Washington University, St. Louis, Missouri; Charles Dollard, President, Carnegie Corporation of New York, New York, N. Y.; Robert F. Loeb, Bard Professor of Medicine, College of Physicians and Surgeons, Columbia University, New York, N. Y.; Andrey A. Potter, Dean of Engineering, Purdue University, Lafayette, Indiana.

A Goal for American Engineering Education*

By S. C. HOLLISTER

Dean of Engineering, Cornell University

During the past two years this Society has been deeply concerned over the shortage of engineers which became apparent about three years ago. This shortage is deepening in accordance with earlier predictions, and will not reach its lowest point for another year or two.

The situation has raised many important questions relating to overall manpower of the nation. That we are engaged in a vast technological struggle is generally recognized. At the same time, the technological character of our economic and social system is at the highest point in history, and is continually accelerating. Overlying these is the urgent necessity for men in military service. As a people we have become accustomed to the mistaken idea that the source of America's strength is inexhaustible. Some are now beginning to realize that, as with strategic materials, there is a limit not only to manpower itself but also to various categories of capacities and abilities of men. There is a limit to what we may expect from campaigns to solicit more engineering students from among the high school graduates. In turn there is a limit to the number who may graduate from high school. And there are other learned fields to be serviced besides the field of engineering.

A Limit to the Source of Supply

At various regional meetings during the past year I have spoken about the likely limits of flow from high school into the engineering colleges. If we assume that the intelligence level for the learned professions lies above an I.Q. somewhere between 115 and 120, we find that 120,000 males of a given age group, say 18, are available for annual entry into these fields. This number of youth must supply medicine, science, engineering, law, theology, and the upper levels of the teaching profession. The number must be discounted to allow for those who are lacking in ambition, emotional stability, perseverance, physical fitness, or economic means. It would appear that under normal circumstances less than 40,000 freshmen may be expected annually to enter the engineering schools. Thus the number of males of a given age group having an intelligence level suitable for the pursuit of engineering study is a fixed percentage of the age population, a percentage which we have reached in our current freshman enrollment of 38,000.

If by artificial stimulation a larger number than 40,000 is persuaded to enter engineering schools it will probably be at the expense of enrollments in the other learned fields. It must be remembered also that to some extent a number of schools are admitting students possessing a lower intelligence level than 115 to 120. They will be successful or not, academically, in accordance with the level of the program in such schools.

Need for Engineers Increasing

Surveys indicate that the present need of industry and other agencies for engineers is of the order of 80,000. The number of engineering graduates this year and in several coming years being 20,000 or less, it is clear that we are markedly short of meeting the need. It must further be

* Presidential Address, ASEE Convention, Dartmouth, 1952.

recalled that with the operation of the present R.O.T.C. and other military programs, substantially more than half of the engineering graduates may go directly into military service for two or three years at least, during which time they will for the most part not be used in technical work. They would be available to industry only after return from service, by which time their training will have been dulled to some extent due to technical inactivity.

Assuming that we are in an international situation which will persist for many years, it becomes clear that continuity of education at least for all of the specialized personnel necessary for our social, political, economic and military system must continue in full force. The present Selective Service policy is clearly based upon this concept. It is placed in jeopardy, however, by the mistaken concepts in the public mind relating to democratic practices. It is thought to be democratic, for example, only if all boys of age 19 at once enter military service. It is overlooked that in addition to equal obligation for service each man should serve in his maximum capacity. It is overlooked also that a democracy must have leaders at all levels, and that people capable of leadership in a democracy have an obligation to exert such leadership. All of these misconceptions are also endangering sound policy relating to the training of leaders which is, or at least should be, the prime concern of our institutions of higher education.

According to the census there was one engineer to about 250 workmen at the turn of the century; today there is one engineer to about 50 workmen. As industrialization has intensified, the number of engineers necessary to operate the system has rapidly increased. However, it should be noted that this increase is not going to continue, since as described earlier, the number of freshmen normally entering engineering is a fixed percentage of the age population, and this percentage is not likely to increase. Thus the increase of engineers as percent of the population has reached a stopping point.

We have not reached a stopping point, however, in the increased need of engineering services in our modern economy. In fact, as it becomes more and more complex, the number of engineers needed is constantly increasing. At the same time, the level of knowledge of the engineer is constantly advancing. This gives rise to the need for some study of the engineering profession itself—how it is constituted, and how it renders its service to society.

Reorganization of Professional Function Necessary

According to the census, there are approximately 450,000 engineers in the United States. This is more than double the number of scientists or doctors. Why this great difference?

The medical profession has long since had the services of nurses, therapists, laboratory technicians, and others trained in the support of operations surrounding the work of the doctor. Thus the health service is directed by the doctor, but is furnished by the entire group working as a team. The same is true with the service of the scientist, who is supported by mechanicians and laboratory technicians of a wide variety.

In the engineering profession, however, many college graduates get no further than the junior positions in the profession, or are utilized in peripheral activities relating to, but not a part of, the profession itself such, for example, in salesmanship, advertising, marketing, etc. Some personnel from trade schools or from technical institutes serve as engineering aides in the drafting room, laboratory and field, but their numbers do not bear the proportion to the number of engineers that would be true, for example, of aides in the medical profession.

In industry there is a tendency to use the junior engineer in a wide variety of services for which engineering training is admittedly good, but not absolutely essential. Furthermore, so long as the supply in the past has held up at a good level

it has been possible for employers to continue the use of these men in junior positions for longer periods than would be justified in terms of their training and experience.

As matters now stand it appears that we have reached a turning point in the profession. With the percentage of the population to be made into engineers no longer on the increase, but with the amount of engineering service needed in the economic system constantly accelerating; and moreover with the evidence of the disparity of these two situations abundantly evident before us, it now becomes clear that a complete reorganization of the profession must take place over the next few years if the engineering work of the future is to be achieved at the level demanded by our economic system.

It also becomes clear that in this gradual readjustment three major factors will have to be given special attention:

1. the training of more aides to support the engineers;
2. the change in practice of utilization of engineers by industry and other agencies employing them; and
3. the education of the engineers themselves.

It is this latter consideration that is of prime concern to us as members of this Society.

Problems in Engineering Education

The Engineers' Council for Professional Development, in a report on Adequacy and Standards of Engineering Education, calls attention to the fact that in most engineering colleges the curricula in at least civil, mechanical, mining, and electrical power engineering have not changed materially in the last forty years. The Council views this as evidence that the curricula in these fields are not keeping abreast of professional and industrial demands. This report was referred to this Society for its immediate consideration. It has been published in the Journal.

Prior to World War II a number of engineers trained in Europe were from time to time taken into industry and into the colleges to strengthen our engineering staffs. Since the war there has been a considerable number of these European engineers who have come to this country. Those trained on the continent were trained under a system in which the work for the first degree was equivalent to about one year beyond the master's degree in most American engineering schools. With such training they stand out spectacularly in our engineering staffs and have made significant contributions.

The introduction of European trained personnel is not peculiar to the engineering profession. In the fields of mathematics, physics and chemistry are to be found many scientists trained abroad. Prior to World War II it was common practice to send many of our American students to be further trained in Europe, particularly in Germany. With the disruption of European education brought about by World War II this practice has practically stopped.

Dr. Wickenden, in his famous report on engineering education made to this Society in 1929, said at that time: "Technical research has depended in large measure on men of European training or upon men trained in pure science. These conditions are gradually being corrected, but American engineering is still far from being self-sufficient on its higher intellectual levels." In the twenty years since that statement was printed the situation has not materially changed, except in isolated areas.

Many engineering educators who might have undertaken to stimulate membership in technical societies from among their students have heard the remark by these students that they find little that they can understand in technical literature published in the Society *Transactions*. To the extent that this may generally be the case among our engineering graduates, it represents correspondingly the extent to which our graduates may not be able to keep abreast of future developments as they occur. If they cannot understand the literature that is at present current, how are

they to keep abreast of the developments of the future?

It has been said that much of the advanced literature appearing in the *Transactions* is written by people having graduate degrees and that therefore it is necessary to have graduate instruction before one may be expected to understand the material in such *Transactions*. If this be true, would it not tend to limit the membership to those who have done graduate work? Would it not be a better policy to strengthen the backgrounds in mathematics and science in our undergraduate programs to such an extent that a man through self-study may come to understand the technical literature and thus keep abreast of developments in his field?

It has been observed that the shortage of engineers has been considerably intensified because graduates of earlier years cannot cope with the problems now before us. If this be true, and there appears to be abundant evidence to support the statement, it arises from either of two sources: either the training has greatly obsolesced in value to the individual, or it was not up to the proper level in the first place. While it is always true that one cannot anticipate the nature of professional practice a couple of decades hence, it is in general possible to instruct in the basic principles to the extent that will make it feasible for the individual to keep abreast of such developments through reading. Studies of case histories would indicate that in the main the engineering training in the past has not been of sufficient strength in terms of basic principles to allow the individual to keep abreast of modern developments.

Evolution of American Engineering Education

Perhaps a better understanding of the present situation might be had by reviewing briefly the evolution of engineering education in this country. In 1866 there were about six engineering colleges of established reputation, and only 300 men had been graduated in the previous 31 years. By 1870 the number of engineering colleges had risen to 21 and the number of engineering graduates to 866. By 1896 the number of institutions had increased to 110, and today the number is 192, of which 148 have one or more curricula accredited.

In 1896 an attempt was made by this Society to rate the schools then existing. There were 31 Class A colleges requiring for entrance at least algebra through quadratics, plane geometry, solid geometry, or plane trigonometry. There were 33 Class B colleges requiring algebra through quadratics and plane geometry. There were 25 Class C colleges requiring less than algebra through quadratics and plane geometry. There were 18 Class D colleges not offering complete courses in engineering, but giving analogous work, and there were three Class E colleges having no entrance requirements as such but doing work of an engineering nature. It was in this situation that this Society, organized in 1893, began its work. There is no question but that the leading spirits in engineering education, through this Society, exerted great influence in the raising of standards of the schools during the early part of the present century.

During that first decade of the present century the four-year engineering curriculum was pretty well crystalized. Its major features have remained practically constant in the older curricula for the past forty years.

Wickenden comments that "By 1900 it was generally recognized that American laboratory installations and methods for the teaching of engineering were not surpassed and not often equalled in any other part of the world. As much could not rightfully be claimed, however, for much of the theoretical instruction and especially for instruction in design." An examination of curricula of 1910 and of the present day indicate that not very much has been done respecting either the science content or instruction in design, even though Wickenden's observations were written over twenty years ago.

In this country we have relied heavily upon the laboratory report and problem

methods of teaching. In Germany, for a number of decades, it has been the policy to use the project method during the last two years, focusing largely upon design. The project method encourages resourcefulness, ingenuity, and individual judgment, whereas the problem method encourages belief in one and only one solution, and mitigates against resourcefulness, ingenuity, or individual judgment.

In this country, after the turn of the century, came the great development in most of the engineering schools connected with the land grant colleges and state universities. Curricula were patterned after the prominent schools of the day, although not generally at the same level of operation. By the end of the first world war the major development of engineering schools had occupied a period of only 50 years.

Between the two world wars many engineering schools were preoccupied with the problem of the peripheral areas, such as the relation between engineering and business, sales engineering, and contiguous areas in which only a superficial knowledge of engineering would be necessary in order to carry on the work. There resulted the establishment of a considerable number of programs of less than standard quality so far as the engineering content was concerned, although the programs themselves had significant value. While this was going on there was very little strengthening of either the scientific or the engineering content of the curricula.

It was at the end of this period that World War II burst upon the scene. It was soon made abundantly clear that a great many graduates of engineering schools of even recent date could not then cope with the problems with which this country was faced.

Comparison with European Education

From the foregoing, it may be seen that the development of engineering education in this country has received its stimulation largely from within the teaching profession. In Europe the programs in engineering education have been influenced by the strong part played by the state and the engineering profession. In Germany, under such guidance, the pattern of the *technische hochschule* was being well established at the time that our engineering colleges were just beginning to emerge. Seven of the eleven *hochschulen* were set up between 1870 and 1879—two more were added by 1885, and the last two in the early part of the 20th century. It is worthy of note that the eleven *hochschulen* served a population of 80 million people, while in this country with a population of 160 million we have 192 engineering schools of various levels.

In Switzerland the Federal Polytechnic School at Zurich was organized in 1854 at the university level. It exerted considerable influence upon the development of the schools of Germany and Italy.

We know that, following the war, many German scientists and engineers were taken behind the Iron Curtain. Undoubtedly the Russian schools which are patterned roughly after the German *technische hochschule* have been greatly strengthened by this inflow of German-trained technical men. We learn from our own technical press that up to 1948 Russia was graduating about 30,000 engineers a year and about 70,000 technicians a year. While I am told that the Russian schools are deficient in laboratories such as are employed in engineering schools in this country, the technical content is at least equivalent to that for the master's degree in most American schools.

The great success of the technical schools on the continent of Europe has been made possible by the quality of preparation received by the students entering such schools. In our own country the high school system, which now graduates half of a given age group, has reached proportionately more youths than similar schools in any other country. By the same token the students are not so highly selected and hence cannot receive so strong a preparation as was true in the German *gymnasium*. The effect upon *our* university and technical college system is of course that we must pick the student up

at an earlier point than would be true in the *technische hochschule* in Germany or Switzerland. In planning our programs we should not be guided by the number of years spent by the student in our university or technical college system so much as we should be guided by the quality of the end result of the total program offered the student.

A Program of Action

I have appointed a committee, under the chairmanship of Vice President Grinter, whose prime function will be to aid in the stimulation of a thorough review of our engineering educational procedures judged in the light of the technical needs that may be required in all parts of this country. It is the hope that every campus will have an active, thoughtful and far-seeing committee working on this problem for the purpose of development of a policy respecting the quality of engineering education that can be used on a national scale.

This study should be made not alone with respect to the meeting of the immediate needs of the profession and of the country. Students now being trained in our colleges will be responsible for the professional attainment over the next three decades. This need, as well as the present need, must be serviced by the training we are giving now.

I would urge all who have a part in this study, and in the training of engineers for their future service to their community to see that due provision be made for the development of intellectual and moral growth on a broad base. We must not be caught in the act of preparing for a world of materialism alone. Materialism has its distinct use, but it occupies one part in a full life which must preserve and enhance its cultural and spiritual values.

I do not wish to be interpreted as recommending the adoption of the *technische hochschule* system in this country. We do not have the preparatory training necessary to support such a system. It is clear, however, that some of our schools at least should attain a level of training comparable to that attained by the *technische hochschule*.

Since in the future engineers themselves are not going to be available in numbers sufficient for use as engineering aides, it will be necessary to see to it that such aides will be trained in adequate numbers. It is essential also that the training for engineering aides be well articulated with training at higher level so that good students capable of advancement to higher level training may transfer easily without serious loss of time.

It may possibly be worthwhile for certain schools having the necessary strength of staff to undertake a program of training at a more advanced level than is commonly employed in engineering schools today. If such programs are undertaken, however, they should be articulated with programs at other levels.

In review of the foregoing discussion it seems clear that consideration should be given to a number of important factors, among which we could list the following:

1. The levels at which different types of programs would terminate, and the manner of articulation between programs.
2. The overall length of programs in order to achieve their objectives.
3. The extent to which existing programs should be strengthened by further training in science.
4. The manner in which science training in a given program may best be exploited throughout the remainder of the program.
5. The manner in which creative work, such as design and development, may be enhanced by training techniques during the course of the program.
6. The character of staff necessary to carry out the whole enterprise.

Obviously there are other factors that should properly be included in so large a study, but these will become evident as the study is carried forward.

The Society's Responsibility

America occupies a peculiar position in the world today. As a nation we are obliged to be ready at all times adequately to defend ourselves. More than this, we have made it clear that we will aid others to defend the freedom of men wherever their subjugation is threatened. We look upon these freedoms in the historical sense that they have been hard won over centuries of struggle, and we do not propose to lose them without a fight to the finish. To be effective either by ourselves or in concert with our neighbors we must depend on quality rather than numbers in our engineering and scientific position. We are now substantially on our own with no opportunity to draw upon men from other places for specialized leadership in this country.

This Society, constituted as it is from all phases of engineering education, has the grave responsibility of leadership in technical education, not alone for ourselves but for that whole segment of the world that looks to us for leadership. All parts of the Society share in this responsibility.

Last Call

for

Learning Aids to be Reviewed

by the following divisions of the Society

CIVIL ENGINEERING
ELECTRICAL ENGINEERING
MECHANICAL ENGINEERING
MECHANICS
MATHEMATICS

These are to be published in a catalogue by the ASEE Committee on Teaching Aids in approximately June of 1953. Items for review *must be received* by January 15, 1953.

Will you please help this activity of the Society by doing one or more of the following:

1. Send us models, pictures, drawings, charts, etc. that you have made as learning aids.
2. Send us information of any of the above which have been made by your colleagues.
3. Let us know of industrial learning aids which you have used and liked, wholly or in part.

Any offer of a learning aid to be reviewed should be submitted to the Chairman of the Teaching Aids Committee

Professor Carl W. Muhlenbruch
Northwestern Technological Institute
Evanston, Illinois

The offer will be forwarded to the appropriate reviewing committee.

Military Research in the Universities*

By JAMES R. KILLIAN, JR.
President, Massachusetts Institute of Technology

As the representative speaking on this panel in behalf of the universities, I am under obligation to make my personal opinions and biases perfectly clear. I head an institution which has reluctantly felt it necessary in the public interest during the past twelve years to engage in military research on a substantial scale and which looks forward eagerly to the time when this will no longer be necessary. I reflect this policy and experience of my institution. I am aware of the hazards and difficulties inherent in military research and share the apprehensions about it which have been expressed by numerous educators. I speak out of experience in saying that the conduct of large classified military research projects imposes vexing and heavy burdens on the university.

Except in time of war, the acceptance by universities of large research projects devoted to classified development work (which is the kind of sponsored research discussed in this paper) can be justified only on the basis of national need, by the fact that the university is uniquely qualified to do the work, and by the possibility that the research will advance education. A technological institution has special resources which impose on it a responsibility to undertake military research different from an institution such as a liberal arts college.

In this period of rearmament, the universities and university faculties generally must undertake defense research and other emergency services for the government because these services are needed. They must accept their proper share of responsibility in meeting the security needs of the nation. Thus they are faced with the difficult dual responsibility of assisting the government in its immediate emergency needs while at the same time preserving as fully as possible their basic and long-range activities in education and research, which is their primary responsibility. Normally, all the activities of the university should be tested by their contribution to the advancement of knowledge.

Is it possible to discharge this dual responsibility? Not without some sacrifice of long-term goals in my judgment. Our problem is to minimize this sacrifice.

With this statement of my personal views, let me now turn to some quantitative facts about the over-all situation.

Research is a Huge Business

The conduct of research, together with the allocation of research funds, has become a huge business in our country. Informed estimates of the total expenditures for research in the United States approximate three billion dollars a year, a sum almost as large as the total federal budget twenty-five years ago and now equal to about one per cent of the national product. Who pays for this research? At the present time the government pays for 55 per cent, industry 40 per cent, and the universities 5 per cent. Ten years ago industry paid for 60 per cent, government 35 per cent, and the universities again 5 per cent. The 1952 figures, of course, reflect the great expenditures by the government for defense research. But the sig-

* ASEE Meeting at Dartmouth Panel on "The Impact of Government-Sponsored and Government-Operated Laboratories on University Teaching and Research"—The University Viewpoint, June 24, 1952.

nificant fact that remains is that the government has become the chief agency for initiating and financing research.

We all can join in hoping that this is a temporary condition dictated solely by national security requirements.

The distribution of the research dollar is of course less significant that the distribution of the research man. The best available figures show that at the present time there are some 600,000 scientists and engineers in the United States. Of this total, about 70,000 scientists and 55,000 engineers, or a total of 125,000, carry the research load of the nation. Of this total of 125,000, some 60 per cent are in private industry, 33 per cent in government, and 10 per cent in universities and other non-profit institutions such as hospitals. If these estimates are correct, the principal load of basic research in the United States is being carried by about 12,000 scientists and engineers. The last estimate which I have seen indicates that of this number, about 9000 to 10,000 are in the universities, the remainder being in hospitals and other non-profit institutions. It is this small handful of men on whom the nation is dependent for most of its uncommitted research as well as a great volume of applied reseach. This is the most graphic way I know of for pointing out how important it is that we provide the best possible conditions for this handful of men to carry out their work effectively and that we give them support in the form that will free them for creative activities. It is also the most graphic way available to point up the disproportionately small amount of our total creative scientific manpower effort that is going into basic uncommitted research.

Twenty years ago, 15 per cent of the nation's total research expenditures came from funds possessed by the universities. To a considerable extent these were funds that permitted free and uninhibited use. Today the universities on their own have funds which are equivalent to only 5 per cent of the total national research expenditure. Is it not proper to conclude that they have lost freedom of action in proportion to this decrease in the percentage of total expenditure, even though they have greatly increased funds available to them for research.

This is a function of funds, of emphasis, of environment, and of men. The funds hardest to come by in my experience are relatively small funds to exploit some new idea that does not yet justify support in the form of a specific grant by an outside agency. By contrast, it is relatively easy to obtain funds for research projects well under way. We need venture capital in education no less than in our economy.

Need for Fundamental Research

No group appreciates more clearly than this one the need for a strong program in fundamental research; of that I am sure. But I am also sure that we have been more successful in talking about the importance of fundamental research than we have in doing something about it, and I need only to point to the reluctance of Congress up until this point to make adequate funds available to the National Science Foundation. This failure to support the Foundation with funds has been a loss to basic science and the long-term welfare of the nation. Funds are far more readily available for applied programmatic research than they are for uncommitted research. Every research institution that I know feels its hands tied because most of its research funds are restrictively earmarked for specific use. We have no mobile reserve troops to rush in to exploit a breakthrough; no funds free for reconnaissance of new terrain. This may seem strange in the face of the fact that total research expenditures in this country have increased ten times in the last twenty years, but it is true nevertheless.

The situation is much better than it otherwise would be because of the well-conceived basic research policies of the government agencies which contract for research in the universities. The Office of Naval Research has done a superb job in stimulating and supporting basic research. In the Department of Defense, the Research & Development Board has steadily

supported the concept of basic research in those areas where the advance of knowledge is important to the military effort. The Department has only recently reaffirmed this policy, which provides for the support of basic research performed as an integral part of programmed research committed to specific military aims and for the support of academic research that promises ultimate military application. The limiting factor here, of course, is the test which must be applied that the research promises ultimate military application. The National Institute of Health, the Atomic Energy Commission, and other government agencies have been similarly concerned with the support of basic research.

The magnitude of the defense research program at the present time is of course the largest part of our total national research effort, both in terms of dollars and men. It is here that the shortage of manpower begins to pinch. There is no question but that the manpower resources are thinly spread. This is especially true in terms of the handful of people who have the imagination and creative powers to provide the leadership required for steady progress. Perhaps our most critical present problem is how to utilize more efficiently this small number of available leaders.

Training of New Leaders

Related to this problem is the training of new leaders. With the present manpower spread as thinly as it is in our universities, are we maintaining the quality of advanced education that is so essential and are we providing the environment in which the truly creative mind has the best opportunity to develop and to do creative work?

Again the answer must be qualified and not a clear yes. Some gifted teachers have shifted from teaching to military research. The interest of others has been divided or diverted. As a result there has been an undeniable loss in total teaching and research effectiveness. There is also some evidence that we have not been educating in this postwar period as many highly creative minds as we might have expected. Offsetting this is the fact that government research has increased our capacity to train advanced students and has frequently improved the quality of our education. In the engineering field, especially, government-sponsored research provides enlarged thesis projects which have given a new dimension to graduate training. The larger-scale projects afforded by sponsored research enable young engineers and scientists to acquire research techniques which can be learned only by participation in organized team research. Some of the sponsored research laboratories in universities have been superb training grounds for research engineers by providing them with the experience which has accelerated their creative contributions to industry.

Any casting up of debits and credits must lead to the conclusion that in the long term, a heavy burden of classified development research will be a handicap to our universities and in the long run a handicap to the security of the nation. I must agree with Whitehead when he defined the task of the university "as the creation of the future." This is especially true of our schools of science and engineering. But they also must help protect the future by aiding our defense in the current emergency.

All of us share the hope that the military responsibilities of our universities can be reduced as rapidly as consistent with national security and that we can concentrate on our main objective—the unhampered advancement of knowledge. We hope for a condition where the best minds in science and engineering in the universities will feel it proper and of first importance to give primary attention to long-range goals.

One of the best ways for the employment of our university personnel for military purposes is the Hartwell type of project, or study group. Under this arrangement, a group of highly qualified men come together for a brief period of time and examine a problem in a fresh

and uninhibited way. Several projects of this kind have been enormously productive, having made major contributions to military thinking and planning. A major advantage of this type of use of scientific manpower is that it does not uproot the men nor divert them from their normal educational and research activities except for a brief period of time.

This study-project technique also aids in informing an increasing number of qualified scientists and engineers about military problems and thus builds up an informed pool of men ready to help in a more critical emergency.

There are a number of large research projects with military objectives managed by the universities. These projects are vitally important and must be seen through. It is important, however, so to manage these projects that they do not improperly or seriously disrupt the educational programs of other institutions through unreasonable competition for manpower, particularly through excessively high salary incentives. These large projects are being managed carefully to avoid this effect, and it is now clear that they can be handled without seriously weakening the over-all educational resources of the country. It must be said, however, that these projects cannot get as many top-flight men as they need for maximum effectiveness. We must accept this shortage as a necessary balancing of forces if we are to continue an adequate amount of fundamental educational and research activity while serving the government's military needs.

Financial Aspects

Let me now turn to some financial aspects of sponsored research. For many years the research activities of our non-profit institutions have been largely supported by grants in aid, which pay only a part of the total cost of the research. The institution has been expected to take care of all indirect costs together with the salary of the principal investigator. Now this system would have been fine if the resources of our institutions increased in proportion to the increase in the volume of research, but this has almost never happened. We have witnessed a great increase in the total volume of grant-in-aid research while the effects of inflation were actually reducing the institution's own income. Frequently we in the institutions have not recognized the impact on our economies of these opposite trends and we have steadily incurred added indirect expenses while happily watching the total volume of grants-in-aid increase. The reckoning has been inevitable and many institutions are now beginning to realize that they can pile up grants-in-aid until they bankrupt themselves.

This is not a problem primarily for the agencies making grants-in-aid. It is a problem primarily for the institutions receiving these grants. We should not delude ourselves that grants-in-aid do not cost anything. We should also realistically budget funds for our part of the cost of the grant-in-aid so that we know what our own contributions are toward the costs of the project. We in the research and educational institutions need a better cost accounting of our indirect research costs. My own experience with the budget of an educational institution indicates that the overhead cost of this kind of institution approximates 50 per cent of the salaries and wages of the personnel working on research. Some institutions run higher than this, others somewhat less, depending in part upon the volume of research which is done.

It is my personal conviction that the federal government must face the problem squarely now that it is financing about 55 per cent of all the research in the country and is spending many millions of dollars on research at non-profit institutions. This vast research expenditure could do serious damage to the economies of these institutions if it were handled purely on a grant-in-aid basis without contributing to indirect costs. It is my conviction that the government should accept a trustee responsibility not to so handle its research funds that in the long run it will weaken the institutions utilizing these funds. A

related matter which is an ever-present concern of the colleges is the extent to which we are coming to depend upon current funds. Since 1940, the operating expenses per student in those institutions on which I have figures have risen about 80 per cent. This additional cost has been to a large extent covered by current or "soft" income. This is a perilous situation and one directly related to the support of research by the federal government. It points up again the importance of sound fiscal policies in our institutions as well as the importance for the government to plan its research programs in the universities to insure maximum stability and continuity.

Our policies in dealing with these fiscal matters, let me add, must be formulated in the interest of educational and research objectives and not narrowly for financial considerations.

Restrictions

Another acute problem posed by government research in educational institutions is the imposition of restrictions, paper work, accounting, and other impedimenta which are foreign to the methods of operation of the universities. One of the reasons why our educational institutions can be effective in basic research is that they have created an environment benign to this kind of activity. The effectiveness of this environment in part results from the absence of restrictive procedures that are perfectly appropriate for other types of organizations, as for example, procurement procedures for accounting, property accountability and purchasing. When the government requires these procedures, it tends to reduce the effectiveness of the institution receiving the grant and to change its character. This is a complex problem that is occupying the attention of many people both within and without government, but I think it important to reiterate it if for no other reason than the improper application of policies and restrictions on our universities will reduce their usefulness and their effectiveness in handling the government research which is needed.

Under present conditions it is not possible to avoid all research requiring security restrictions, but we must admit that such restrictions do damage to the ideals and programs of our universities. The imposition of restrictions on publication of research results, either for secrecy or patent reasons, can become incompatible with the basic concept of an educational institution as a source and distributor of knowledge. Any arrangement which inhibits free and effective work in any scholarly field involves a penalty. To minimize the effects of classified research, the university should seek to segregate it as much as possible so that it does not limit freedom of communication within the normal program.

Summary

It is perfectly clear to you that my remarks have been largely of a clinical nature. I would summarize by saying that it is largely up to our educational institutions to face up to the problems of sponsored research with wisdom, with independence, and with strict adherence to their educational ideals. It is not proper, in my mind, for an educational institution deliberately to seek a military research project with selfish or financial motives in mind. It is only proper for it to do so when its services are needed by the nation.

If we were to review the history of the world's great universities, we would find, I venture to suggest, that their periods of greatest achievement were periods when they most effectively responded to the pressing needs of their times. For the universities to seek each individually best to serve our period in our own way is the only general guiding principle which we can apply in accepting or rejecting or conducting military research.

The Atomic Energy Commission Looks at the Future*

By T. KEITH GLENNAN

Commissioner, U. S. Atomic Energy Commission
President-on-leave, Case Institute of Technology

The Atomic Energy Commission and its staff are keenly aware that if atomic energy is ever to be made importantly useful in peacetime applications, we must depend to a large measure in the coming years on a tri-partite team. Industry, educational institutions, and government must each take an effective part in this development. This team must be strong as individuals and particularly strong as a team if we are to be successful.

Industry must do its part by participating in atomic energy developments even though significant short-term financial return on investments may not easily be foreseen. This business, if one can call it by that name, is still so young that the opportunities to develop new processes or products are not readily apparent. Nevertheless, the atom is too fundamental to be ignored and our knowledge in this field is increasing at a rapid rate. Industry is beginning to awaken to this situation and to inquire as to the manner in which participation can be achieved. The Commission welcomes and is encouraging this attitude believing that production interests will best be served in the long run by the competition engendered by the participation of production people.

Our universities, and particularly the science and engineering schools, must take on even greater responsibilities in research and in training the new generations of scientists and engineers. These institutions must turn out the required number of professional personnel, well-trained in the fundamentals of science and engineering and equipped to fit into the programs of industry and government. Here, too, there are increasing and encouraging signs of interest on the part of the educational world. The Commission has long maintained a policy of leaving educational matters to educators and it is gratifying to see the manner in which the educational fraternity is accepting its responsibility in this new field.

Today the government is in the dominant position by reason of an act of Congress and because there is no effectual international control of atomic energy. It must be the continued responsibility of national governments to maintain complete control of fissionable materials, each within its sphere of influence. Our government must, whenever consistent with the assurance of the common defense and security, act so as to strengthen free competition in common enterprise, improve the public welfare and promote world peace. Changing conditions as we go forward will alter the relative importance of each of the members of this team but these changes in importance will occur only if the industrial and educational partners are well-informed and interested.

Present Situation

Let's look for a moment at the present state of the art and then address ourselves

* Annual Meeting of ASEE, Dartmouth College, Hanover, N. H., Tuesday, June 24, 1952.

more particularly to the developing needs of this field which will be of interest to the engineering-educational fraternity. We know how to produce fissionable materials and to produce them in substantial quantity. While great advances have been made in the technology involved in the separation of U–235 atoms from U–238 atoms and the transmutation of U–238 into the end product plutonium, it must be remembered that throughout the past nine years almost all of the work in this field has been to meet military and defense requirements. Such an atmosphere is not particularly conducive to relaxed thinking and the taking of extraordinary chances in the search for radical improvements. Nevertheless, it can be said that fissionable material is in reasonably abundant supply and that our supplies are becoming increasingly large at an accelerating rate.

We know how to manufacture destructive bombs of many types on mass production schedules. We have substantial stockpiles of atomic bombs. We are expanding our plants for the production of fissionable materials and enlarging our manufacturing activities to enable us to make even more weapons. Our development centers are busily engaged in finding ways of better utilization of these still precious fissionable materials.

We are building mobile reactors for naval use. If we are successful—and there are now only a few skeptics left—there will be a firm demand for conversion to naval propulsion under atomic power. We are in the early stages of the designing of a reactor for the propulsion of aircraft. Although this is a job of almost unbelievable difficulty, there is little question in my mind that, given an adequate amount of money and sufficient time, success will be achieved.

We have generated small amounts of uneconomical electric power incidental to the main experimental purpose of a reactor. What the future holds for this production of electric energy from atomic energy only time itself will tell. If reactor developments turn out successfully and costs can be reduced—and I am certain that we will be successful in these matters—there will be an increasing demand for stationary nuclear power plants. This demand naturally will arise first where present costs for electrical energy are high and this suggests that such a program may have an important place in any future Point Four programs. As you probably know, the Commission has made agreements with four industrial groups permitting them to make surveys and studies leading toward the finding of ways by which a larger share of the task of developing, building and operating reactors can be carried by industry. One of these groups, the Dow-Detroit Edison combine, has already agreed to participate in the financing of continued research and development studies. The other groups are not far behind and I assure you that their interest is very real. It is, of course, too early to foresee the results of these industrial studies but I am certain in my own mind that industrial participation and the results of competition in accordance with our normal industrial pattern will hasten the day when the generation of power through the use of nuclear fuels will become an economic reality.

A large and continually growing interest in the use of isotopes for research in medicine, agriculture and industry leads us into another facet of the atomic energy business. You may give your imagination free play in this matter for the importance of the isotope as a research tool cannot be over-stated. I am sure that many of you here could wax much more eloquent than I about the doors which may be unlocked in the future through the use of radioisotopes.

Each of these activities will call for an increasing number of scientists and engineers as the years go on. The actual numbers required will depend upon the degree of success that may be achieved in the developing of the programs. We are just now in a position where we can see occasional glimpses of the atomic energy field ahead of us. We cannot with certainty predict the exact nature of the developments to be undertaken in the next

five to ten years. We do know one thing with certainty—none of the hoped for progress will occur unless the minds of well-trained men are available and interested in this field.

Future Needs for Manpower

So much for the generalities of the present state of the art from which we can take only a dimly lit view into the future needs for manpower in the atomic energy program. The members of this panel have been asked to address themselves to a discussion of the impact of government sponsored and government operated laboratories on university teaching and research. Having become over the years a Jack of all trades and an expert in none, I thought that your interests would be best served in this matter if I asked for the advice and counsel of the directors of our important laboratories. I asked them several questions and propose now to report to you a composite of the answers which were given to me.

My first question was—What is the present need within the atomic program for college graduates in the sciences and in engineering? How many Ph.D.'s are needed annually? How many men with Master's degrees or Bachelor's degrees only?

The Oak Ridge National Laboratory has estimated that they will hire 170 new technical men between July 1, 1952 and June 30, 1953. Thirty of these will be Ph.D.'s, 45 men who hold Master's degrees, and 95 who hold Bachelor's degrees. Half will be in the engineering-sciences.

Brookhaven National Laboratory is just beginning to stabilize in its operations. The large equipment—the reactor, the cosmotron, the cyclotron—are now in use or very nearly ready for use. Brookhaven has a young staff which probably means that their turn-over rates for the next few years will be low. They have been employing 50 to 60 men each year, 30 to 40 of these being Ph.D.'s and 20 men holding the Master's or Bachelor's degree. It is probable that the next year will see a decrease in the number of new hires at Brookhaven National Laboratory. As a guess—25 to 30 qualified scientists and engineers each year may be the going rate of employment at Brookhaven.

Los Alamos—It may be interesting for you to have a picture of the distribution of our present staff at Los Alamos. There are 482 men holding degrees in science —257 holding the Ph.D. degree, 96 a Master's degree, and 129 the Bachelor's degree. There are 192 engineers employed at Los Alamos. Of this number nine hold the Ph.D., 25 have Master's degrees, and 158 Bachelor's degrees. The next 12 months will require a minimum of 170 new scientists and engineers and it is estimated by the Laboratory that the following pattern will obtain: 120 people will be required in the sciences—64 should hold doctorates, 24 Master's degrees, and 32 Bachelor's degrees. About fifty will be required in engineering, two with a Ph.D., 6 with a Master's degree, and 42 with Bachelor's degrees. Their principal interests are in the mechanical, electrical and chemical engineering fields. I would add an editorial note of caution here. I think that it is probable that this number may be substantially increased in the near future. It is highly probable that replacements alone will require a minimum of 75 to 100 persons annually—⅓ of these being engineers.

Argonne National Laboratory. The staff of the Argonne National Laboratory is fairly well stabilized by now. Last year they hired 26 Ph.D.'s, 17 Master's and 26 Bachelor's for a total of 69. During that same year 61 persons terminated, 7 of whom went to other AEC installations and 7 returned to universities for further graduate work.

Going beyond the laboratories, and anticipating a very substantial expansion in our program, money for which has been asked of the Congress, one can estimate that the Atomic Energy program will require, in addition to replacements for people currently employed by the Commission some 4500 scientists and engineers over the next four years.

Cooperation Between AEC and Universities

The other questions asked of the laboratory directors related to the manner in which cooperation was being achieved between the AEC and the colleges and universities. While I am sure that all of you are familiar in some degree with these relationships, I though it might be well to review them again for you. From this recounting it will be evident that the laboratories are having an influence on the teaching and research programs in engineering education. I would guess that this relationship will become more important as time goes on and particularly so as educational institutions themselves begin to pick up a larger portion of the responsibility for training and research in the atomic energy field.

In all of our laboratories graduate instruction is carried on in cooperation with neighboring colleges and universities. Graduate thesis programs have been set up, summer graduate student programs are in operation, summer staff appointments are quite generally available for academic personnel—these situations give an appearance of a healthy, cooperative pattern.

The Oak Ridge Institute of Nuclear Studies, sponsored by 30 universities in the South and Southwest, provides an excellent example of mutual assistance in this field. This regional group was formed to stimulate the development of research programs, to foster and encourage the widespread dissemination of knowledge concerning science and technology, and to provide a bridge between sponsoring institutions and the Commission in the improvement of methods of education and training in the nuclear field.

Assistance is provided to university scientists in making arrangements to participate in the research and development programs at Oak Ridge. Graduate students employed in the laboratory are encouraged to continue work toward professional degrees through the Institute and assistance is given to graduate students from the sponsoring universities in arranging for thesis work to be conducted at the laboratory on both classified and unclassified problems.

It is clear, both from our observations and from testimony of university people, that the Oak Ridge Institute of Nuclear Studies has been highly successful in establishing and maintaining a fine degree of cooperation between the laboratory at Oak Ridge and the university community.

Similar groups have been organized about our other installations. Associated Universities, Inc., composed of nine eastern universities, actually operates the Brookhaven National Laboratory. We are most happy about the increasing effectiveness of relationships between the laboratory and the faculty members and graduate students of educational institutions in the East.

At Argonne National Laboratory we find that approximately ten per cent of the scientific positions in the laboratory are for visiting professors and graduate students working on problems of mutual interest to the laboratories and the universities. At Hanford and at Los Alamos cooperative programs have grown up and are contributing to the health and scientific improvement both of the Commission's installation and of the universities involved.

The Commission has long recognized that science cannot depend upon our present state of knowledge if we are to maintain a rate of advance in the atomic energy field. Accordingly, we are calling on university scientists and engineers to carry out specific research and development projects which have a bearing on our program. As a measure of this activity—we now have in effect about four-hundred contracts with various academic institutions. In general these projects are conducted on an unclassified basis.

The Commission is grateful to the universities and engineering schools for their cooperation in all of these endeavors. We are particularly appreciative when we realize that financial problems of unprecedented severity face most of the institutions involved. We are watching with

interest the development of specific courses and, in some cases, of entire curricula, covering work in the nuclear field. As in all matters in education, it is wise to proceed slowly rather than rushing into a field of specialization such as reactor engineering. It will be the policy of the Commission to continue to supplement the activities of the educational institutions of the country and to provide specialized training only to the extent that the Commission's program requires such activities. Thus we expect to conduct special training courses such as that given by the Oak Ridge School of Reactor Technology for some time to come. We look upon such courses, however, as emergency programs and we hope eventually to abandon them completely or to change them into specialized classified on-the-job training programs.

Fellowship Program

The Commission's fellowship program with which you are all familiar will gradually be taken over by the National Science Foundation. This program, initiated in 1948, has provided support for some 1025 individuals in either the pre-doctoral or post-doctoral programs of the Commission. It is too early to predict the impact of this particular activity on our national atomic energy efforts. It is clear, however, that each of the individuals involved will be making direct and indirect contributions to the Commission's program.

You may ask me what universities and colleges can do to assist further. My reply would be to continue your traditional science and engineering curricula—and even turn out a increasing number of well-trained, well balanced scientists and engineers—strengthen yourselves by the elimination of frivolity and a dependence on Washington for financial support. Prepare yourselves thoughtfully to take these new ideas to the campuses and above all be cheerful and enthusiastically aggressive.

Sections and Branches

The **Michigan Section** met in the Engineering Society of Detroit building under the auspices of the University of Detroit on Saturday, May 10, 1952. W. P. Godfrey, Section Chairman, presided at the 2:00 o'clock session. Members and guests were greeted by The Very Reverend Celestin J. Steiner, S. J., President of the University of Detroit. S. C. Hollister, President, ASEE spoke on the topic "Adequacy and Standards of Engineering Education." Following this paper, L. E. Grinter, Vice-President ASEE spoke to the group on "The Improvement of Teaching."

At a brief business session in the evening, the following men were nominated and elected to serve as officers of the Michigan Section for the 1952–1953 year: Chairman—C. C. Winn, Vice-Chairman—F. L. Schwartz, Secy.-Treas.—C. C. Sigerfoos. W. P. Godfrey, was appointed to represent the Michigan Section on the General Council of the National ASEE.

"Educating Engineers for 2000 A.D."*

By C. C. FURNAS

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It may be appropriate to begin this discussion by calling up a voice of the Fourteenth Century, "The lyfe so short, the craft so long to learne."[1] Certainly since Chaucer wrote these words some six hundred years ago the situation has not eased. Though the span of human life has lengthened very substantially and very beneficially, the task of learning the craft has grown many times greater, particularly in the field of engineering. The operation of exploring, investigating and criticizing the process of educating for engineering and carrying on with the profession itself is certainly going to be a standing order for a long time.

May I also observe that the task of educating engineers for 2000 A.D. is not a chore for the next generation alone, but is an operation which faces us now because those who are presently graduating from various educational institutions will, in some cases, be active in the profession of engineering when the twenty-first century begins.

One would be very foolish, indeed, if he approached this subject with any great feeling of confidence. Rather he should approach it with a large amount of trepidation—which I do. I assume only one thing, namely—that a large number of people concur that there are and will for some time be a number of unsolved problems in engineering education, and that the number of different proposed solutions will just about equal the number of persons who are willing to offer them. Since my deliberations will have no more merit than dozens of others that you probably have heard, or will hear in the future, or that you can devise yourself, my contribution is merely that of another person's thinking—for whatever it may be worth.

What Is an Engineer?

In attempting to solve a problem, it is usually considered good form first to analyze the situation (the old formula for rabbit soup: First you catch your hare). My analysis shall consist largely of a series of observations on the characteristics and functions of the people who make up the engineering profession.

When one seeks the answer to the question, "What is an engineer?" he gets a surprising variety of answers. The ideas of the function of the fraternity are far from unanimous among its own members. At one end of the spectrum of opinion there is the thought that the true engineer is a research man of some specialized learning and an unusual set of talents—C. F. Kettering might be taken as an example. At the other end is the person who considers that the engineer is essentially a scientific business man—Herbert Hoover, for instance. It is obvious from the responses that engineers are of all sorts, kinds, and sizes. Even less agreement is found among engineers themselves and among the educators as to how the individuals who are to make up this polyglot product should be treated in the educational mill. Obviously, it would be desirable to find a universal formula that would enable everyone to receive exactly the optimum treatment to prepare him for the role which he is eventually going to as-

* Address at Annual Meeting of ASEE, Dartmouth College, June 26, 1952.

[1] Chaucer—"The Assembly of Fowles," line 1.

sume in our industrial society. That is a fond hope which will never be realized but perhaps we can improve our present performance.

With this discouraging beginning of wide differences of opinion one ceases asking opinions and begins to look at the record to find out just who is included in this profession of engineering; what do they do, and what are the characteristics which seem to make them successful? Even the blind man, by making enough tactile observations, can determine the shape and character of the elephant.

First, as to numbers. The number of engineers is, of course, partially a matter of definition, but the professional engineering societies of the country have reasonably exact criteria and those who are included by the rough definition of the profession number about 400,000 in the United States at the present time. They are, then, somewhat less than 3/10 of one per cent of the population and, hence, a relatively select group—at least as far as the census taker is concerned. One's first conclusion then is that if engineering calls for specialized education, it cannot be of a universal character because you cannot shape a major share of the national educational system around only 3/10 of one per cent of the members of society—no matter how important they may be.

Delving into the data a bit further, one finds that hardly more than 15 per cent of the engineers are, at the present time, in the field of research and development. This, then, indicates that the brand of critic who feels that engineering education should be devoted only to the preparation for research and development is about 85 per cent wide of the mark, at least as far as the number of people that are involved. I am not in a position to give any exact substantiation of the fact that only 15 per cent of the engineers are in research and development, but there are a few data from the Human Resources Division of the Research and Development Board for the year 1952. Admittedly, they are estimates but probably not far from the truth. At the present time there are approximately 625,000 scientists and engineers in professional activity in this country. Of these, 9 per cent are employed in universities, 24 per cent in government, 67 per cent in industry. Of these 625,000 scientists and engineers about 135,000 are considered to be in research and development. Here again, of course, the listed occupation depends considerably upon definition. Twenty per cent of these are engaged in universities, 23 per cent in government, and 57 per cent in industry. Since a substantially larger per cent of those who are classed as scientists than those who are classed as engineers, are in research, it appears to be quite a reasonable estimate that not more than 15 per cent of the engineers are engaged in research and development. I would be willing to concede, if anyone wishes to argue the point strongly, that this may be by far the most important 15 per cent, but at the moment I am considering only numbers.

Solidity of the Profession

The data, such as they are, also indicate that the engineers constitute a fairly solid fraternity, as far as the educational link is concerned. Most of those who are educated as engineers stay with the calling. Depending upon the estimator and also upon definition, it appears that somewhere between three-fourths and seven-eighths of all of those who have received an engineering education remain in the profession, if you include administrative and executive posts which are closely linked to technical organizations. There is a small and decreasing number who have never received engineering educations who enter the bona fide professional ranks, but new arrivals in these groups are now almost to the point of being negligible. There are a few data, rough as they may be, on the losses to the profession of engineering.[2] Losses by death and retirement amount to about 2 per cent of the number in the profession per year. It is also estimated that

[2] "Employment Outlook for Engineers," Bureau of Labor Statistics Bulletin No. 968, May 1949, page 44.

transfers to other occupations than engineering amount to about ½ per cent of those in the field each year, plus about 5 per cent of the new graduates each year. Thus, the losses by death, retirement and voluntary action are estimated to be about 3 per cent per year. It appears that educating a young man to be an engineer is a fairly serious business because he is probably going to pursue that path until the bitter end.

Another characteristic of the profession is its increasing importance in our industrial economy.[3] In the year 1890 there was one engineer for 290 industrial employees. In the year 1948 there was one engineer for 75 industrial employees. As our civilization becomes more industrialized, it becomes more complicated and relies more upon the services of engineers. Hence turning out the best possible engineering graduates becomes a matter of increasing national concern.

Characteristics Associated with Success

Turning away from the statistics, we can make some observations on the characteristics of individuals who make up the more successful stratum of the profession. In this case one is fortunate to be able to turn to the words of Henri Le Chatelier, one of the prominent scientists and engineers of France.[4] M. Le Chatelier analyzed and compiled the outstanding personal characteristics of the most successful scientists and engineers that he knew in western civilization and came up with the conclusion that four qualities were always present and hence must be basic characteristics of a successful engineer. These were, in order of importance:

1—Activity (or drive)
2—Imagination
3—Judgment
4—Knowledge.

In order to make a check on this judgment of an engineer I turned far afield and investigated an article by a man who made a career of interviewing and reporting on successful business executives in many fields.[5] The author of this article listed eighteen qualities that he had observed in successful executives over the years. The first two were "They work hard," second, "They have imagination" which obviously are in exact correspondence with Le Chatelier's first two prime qualities. The quality which would correspond to Le Chatelier's "Knowledge" in this executive list came as number sixteen in "they are educated." Thus we see that there is a very fine correlation between the most important properties required for success in the opinion of two observers from widely divergent fields.

If I might venture to put in my own two cents worth at this point, I would suggest that there is a fifth quality beyond the four given by Le Chatelier; one which is highly necessary for the bulk of the engineers, namely—adeptness in human relations (that much maligned, much misused term). I am sure Le Chatelier recognized this, and why he did not list it as one of the prime qualities I do not know.

It appears that these five essential qualities—drive, imagination, judgment, adeptness in human relations, and knowledge—fall into three rough groups:

1—Those that can be taught
2—Those that can be encouraged but not taught
3—Those that can be partially taught and partially encouraged.

The first group—that which can be taught—contains but one item: knowledge. That is the area on which the educational institutions, and particularly engineering colleges, have traditionally focussed their major efforts. From the observation of the characteristics of successful men it would seem, offhand, that this is the item

[3] Bureau of Labor Statistics Bulletin No. 968, May 1949.

[4] "The Creation of an Intellectual Elite in Science and Industry," H. Le Chatelier, Société Industrielle de Mulhouse, pages 214 to 235, volume 94, 1928.

[5] "What Makes Executives Tick," by Roy Rutherford, the *Rotarian* Magazine, January 1948.

of lesser importance of the five. May I add in self-defense, however, that I certainly do not believe that one can successfully work from the background of ignorance—cannot operate from a mental vacuum—and there is probably nothing quite as dangerous in any profession as the dilettante—the person who has little knowledge and doesn't know what to do with the little that he does have. Knowledge, though insufficient, is absolutely and basically necessary.

At the risk of diverting the stream of my argument, I should like to make some brief observations on this process of acquiring knowledge. In the field of science and its application, knowledge can be broken up into those homely subdivisions: "Know how," "Know what," "Know why."

"Know how" is the realm of emphasis of the tradeschool or the technical institute. "Know what" seems to represent the center of gravity of activity of most engineering colleges. "Know why" is centered in the field of responsibility of the traditional, pure science curriculum. In my opinion, engineering colleges, as a class have been guilty of having an excessive degree of emphasis on the "know how" and the "know what" and not enough on the "know why." This shortcoming has particularly serious effects for those engineers who end up in the research and development field. There has, however, within the last generation been so much pounding of the drum and beating of the chest about the essential ignorance of our engineers and the fact that they acquire too little of the "know why," that I think there is no point in my dwelling on the matter any further. I observe that there is a gradually increasing emphasis on inculcating scientific understanding into engineering student crania. I think that this is a very hopeful trend and I believe that it will continue.

The second class of items encompasses those which cannot be taught at all—only encouraged, by example and otherwise. In this group I would put the two essential qualities of drive and imagination. The third class of qualities contains those that can be partially taught and partially acquired through encouragement. In this I would put judgment, and adeptness in human relations.

From this line of reasoning I conclude that the bulk of the factors that are necessary for success, cannot actually be taught —they can only be encouraged, and allowed to grow. But nothing grows without a driving force of some sort, so this brings us to the discussion of motivation. In other words: what is it that makes people tick, that an educational system can utilize to improve results?

Motivation

John Mills, long of the Bell Telephone Laboratories Public Relation Department, classified people, at least those that came within his ken, by a very simple scheme. He assumed, or rather observed, that there were four major areas of human interest, or motivation. As an aside I should add that these areas of motivation to be discussed are over and above the three simple biological urges of the human animal—food, shelter, and sex. Perhaps we are discussing the higher levels of motivation. These four fundamental urges, according to Mills, are: "Things, Ideas, People, and Money. The arrangment of these drives in order of their prominence indicates the basic character of the man and, hence, in matters of personnel placement, give a good indication of what he ought to do. For instance, the best type of a person for an engineer might be one who is motivated in the following order: Things, Ideas, People, Money. For the true research man the optimum motivation order might be: Ideas, Things, Money and People. One might observe that since there are four properties and that order seems to be important—there are factorial four ($4 \times 3 \times 2 = 1$) or 24 basic types of people with, of course, gradations between each. I would conclude from Mr. Mills' observation that the educational job to a large degree is to set up environmental practices, human relations, etc., in order to afford optimum opportunity for these various motivating factors to grow and develop in

keeping with the propensities of the individual.

Since I am one who tends not automatically to accept someone else's analysis, I indulged in a bit of cerebral experimentation myself and attempted to set down in order of importance those things which apparently induce or motivate people in the United States to undertake higher education. Selecting my own qualitative observations, I came to the conclusion that the four things that induce Americans to go to college, in order of importance are:

1—Economic reasons (including the woman looking for a man)
2—Snobbishness (including the woman looking for a man)
3—The professional urge (the feeling for accomplishment, per se)
4—Intellectual curiosity.

I regret this order of motivating factors and would like to see it reversed. However, I do not see how I, or anyone else, can do anything about it.

This list which I have just synthesized is, by title, somewhat different from Mr. Mills but is not necessarily in conflict. For instance, the factor that I call "economic" probably corresponds quite closely with that which Mr. Mills' called "money." The one which I class "intellectual curiosity" probably conforms to Mr. Mills' category of "ideas." Between us it would appear that Mr. Mills and I come up with six basic urges or motivation factors which furnish the drive for people in the professional world. Since arrangement of such factors is important in determining different types of people, then we could come up with the conclusion that there are factorial 6 (which is equal to 720) basic types of persons. It will be noticed that $\frac{1}{720}$ is about 0.15 per cent, which is equal to half the proportion of the engineers of the country. So if one assumes that half the engineers are really good, and that the engineer should ideally be one out of 720 types, it would appear that we have a reasonable balance between the motivating factors and the results of our engineering education. This observation, I admit, is pure mental diversion and is not to be taken seriously.

Intellectual Honesty

Perhaps it would seem to be enough of an assignment to consider the intricacies of the elements of success of the engineer as a professional individual, but another facet can readily be viewed in this general discussion—the sociological characteristics of engineers, en masse. During recent decades it has become an increasing popular pastime to chide the engineers and scientists on their lack of social consciousness and conscience—"Why don't you, since you are so smart, do something about controlling the effects of these inhuman Frankenstein monsters you have so cleverly devised?"

There are some who have taken these admonitions seriously, with occasional success, but for the most part the engineers' direct attempts to sweeten and benefit the sociological pattern have been signally unsuccessful—particularly in the realm of politics. These failures are usually attributed to the supposed condition that the engineer is an unemotional cuss, a cold fish, who doesn't understand people. The accusation cannot be accepted in toto. The emotional structure and vigor of an engineer are not particularly different from anyone else's. There are probably few real class distinctions in this field. That he often doesn't "understand" people is probably true. And "people" seldom understand engineers, for the reason that the two groups unwittingly operate from quite different frames of reference. The reason is simple—because of training, background and profession, engineers and scientists, as a class, have a rather high degree of intellectual honesty, and when you get down to cases, relatively few people appreciate, desire or understand intellectual honesty. It is not a popular virtue. It is often far from beautiful and it can have distressing impacts on the emotional reactions.

With great haste, I will add that I am not accusing most of the people in the

world of being "dishonest" in the usual connotation. The average person, in whatever occupation, is scrupulously honest, according to his code. I'm merely saying that many of the codes that human beings have evolved in the process of learning to live together tend to ignore the laws of physics, chemistry, biology and sociology; are loaded with rationalizations; are judged by "What would I like to believe?" rather than "What is really true?"

An engineer knows that a bridge designed by mere wishful thinking will fall down, the chemist knows that he cannot promote a reaction by the emotional waving of banners. Although transfer of training is never complete the engineer, more often than most, adapts this type of logical thought pattern to his dealings with people and then is chagrined and crushed when the mass response is somewhat less than cordial. He assumes, correctly, that the sociological pattern would be greatly improved if there were a strong and permanent inoculation of the beneficent virus of intellectual honesty, but the public will have none of it. We have a civilization of complex gadgets and systems of 2000 A.D. operating in a mass emotional framework which is about the same as it was in 2000 B.C. and the two do not match. Perhaps we're approaching the point of outsmarting ourselves.

The task of improving the basic sociological structure is a serious one and no one has found the solution. Perhaps, however, if the engineer could become a little more adept in his public dealings, and if he could also, in his educational and professional activities, induce a bit of understanding of and appreciation for intellectual honesty in the pliable mind of the general public he might eventually have a substantial effect. This potential sociological role should certainly not be neglected in the pattern of education and training of engineers.

Conclusions

Having now gone through my introduction, by making a quick survey of the field, I will leave out the main body of my talk and jump directly to my conclusions, which I may temper with recommendations. This is unorthodox and perhaps unsportsmanlike, but I have two reasons. First, to go into the discussion of how I go from observations to conclusions would be much too long and probably infinitely boring. Second, I probably couldn't completely defend the steps of my logic anyway. So, if you will bear with me, I would like to throw out my bait just to see how you will react. That is the way you catch fish, and fishing, I might add, is about the highest form of experimentation in the indefinite world; so in dealing with an indefinite subject, this may be the best way to approach it.

Without a supporting rigorous approach (rigor at times being merely rigor mortis) or any delusions of essential defensibility, I suggest that in order to arrive at an improved pattern of engineering education for the year 2000 A.D. five steps be undertaken:

I. Operations Research

That a really major research project be undertaken on "Preparing for the Profession" from the operations research point of view. Operations research I recognize is a much misused, and a much maligned subject but in its proper place it does have very great merit. It deals with the investigation of complex and not completely analyzed situations, with whatever data and tools of logic are at hand in order to arrive at a framework for making optimum decisions for action. It is not a panacea and it is not magic, but certain methods and approaches have been worked out which are effective in complex situations where systems of both animate and inanimate objects are involved. Its greatest triumph was probably in optimizing the system for the air defense of England in the "Battle of Britain," in which, with the use of radar and observers and plotting boards and mathematical doctrines previously set up, the British were able to use their inadequate supply of interceptor aircraft to combat the flocks of German bombers and thus to come out victorious.

Similar success was scored, although not publicized as much, in the antisubmarine warfare. Operations research is now a major tool of military strategy and tactics and is becoming useful in a number of industrial systems and I believe it should have a certain effectiveness in the broad field of education, at least to the extent of delineating what the problems really are and indicating the probable optimum method of attack. In order to indicate what I mean by operations research, may I say that the analytical portion of this paper itself constitutes a sketchy and qualitative approach to the setting up of an operations research problem.

By making the above suggestion, I am implying that operations research may be more effective than research in methods of teaching—that rarified bailiwick of the pedagogue. My own feeling is that the "methods of teaching" approach deals with the problems in much too fine a structure. I also feel that traditional psychological experimentation is not particularly fruitful, because it attempts to be too exact and to put numbers on things which are really not susceptible to being pinned down to numbers. Both these activities may be necessary, but they are not sufficient.

I would also like to suggest, if anyone cares to listen, that this field of operations research in education for the professions would be a very worthy and eventually a very fruitful activity for some of the great philanthropic organizations, such as the Ford Foundation, which are very intent on extending their efforts on improving the human race.

II. Beginning While Young

The professions, particularly the engineering profession, should spearhead a movement to induce the objective teaching of science (for both sexes) from the kindergarten up. The most common characteristics of the youngsters is to ask "Why?". As parents and teachers we seem to be dedicated to suppressing this basic instinct of intellectual curiosity. By the time children arrive in high school, the job of suppression has usually been very thoroughly done. Why shouldn't we take every opportunity to cultivate and to encourage this really basic drive of intellectual curiosity and rationality? Not only would this most important motivation factor be kept alive, but by the time adolescence is reached the average individual might even have acquired a fair sized reservoir of knowledge of what the world is, and how it works. More important, there would be a real respect and understanding for the relation between cause and effect which is, of course, background of science and its application in engineering. As it is now, we have little to replace the vacuum which is left when the fairies pass out of the childish mind. As the years go on this emotional vacuum now tends to become filled with many curious things.

III. Atmosphere of Reality

More reality and fewer synthetic situations should be brought into the college teaching of engineering. This implies that there should be a much closer relation and effective liaison with commerce and industry and the other employers of engineers, throughout the teaching period than is the case at present. I am by no means convinced that the "co-op" engineering curricula, as presently constituted, are the answers but there are virtues there that should be explored.

As a rule, the medical profession probably does a better job of merging practice and teaching during the educational period than do the engineers. The "teaching hospital" concept, in which the medical student lives in the atmosphere of, and participates in varying degrees in the practice may have certain inherent virtues which engineering educators have been neglecting.

IV. Early Selection

Increased emphasis should be placed and encouragement given to earlier selection of careers when misfits come up during the educational period. Misfits are not just a matter of some persons being

stupid. We are all ignorant, but about different things. In my opinion, a great deal could be done—more than has beeen done in the past—on intuitive or measured selection and guidance of apparent misfits toward appropriate alternates. It is a very serious and often a very bitter thing to arrive at the point of no return in this educational journey of ours, and many are the mistakes that have been made because the career has been allowed to progress so far along a given course that it could not be altered.

V. The Continuation Function

After formal education is completed, the educational institution itself should move into industry and commerce, for continuation activities. In other words, university work does not end, or should not end, at the time of graduation. Educational paths are actually never completed as far as the truly professional man is concerned. The craft is "so long to learn" that the chore is never actually finished. Adult education, if you choose, or cooperation with industry, whatever may be involved, I feel should be an essential part of continuing professional education, especially engineering. One sees elements of it here and there, particularly in the state supported universities but, thus far, there is only a feeble beginning.

Perhaps one or more of those suggestions may make sense to some. Whether they do or not, I feel that I must leave the subject at this point. I admit that it is unsportsmanlike to leave the whole matter dangling (like the well-known participle) and ignore the details, but first you catch your hare and then decide how to make the rabbit soup. If this constitutes catching the hare or even a portion of him, it is probably sufficient work for one evening. If ideas have any basic merit in the minds of enough people, something will eventually be done about the details.

The suggestions I make run counter to the long standing tradition that engineering education is merely a four, five or six year stint. I believe it should essentially stretch almost from the cradle to the grave.

I am also implying that industry and commerce should move from their traditionally remote positions, isolated from the educational world. This will cost money and executive effort, but corporate stockholders had better get used to the idea, that is, if they really believe in the basic virtues of a free and reasonably individualistic economy. I still believe in those basic virtues myself but I think their survival will depend to a major degree on a truly effective and material collaboration and rapport between education and the vital, producing units of industry and commerce. It may be a losing battle but I am reasonably optimistic and hope I may still be around in 2000 A.D. to see if my optimism has been justified.

In the News

Ralph Morgen, Director of the **University of Florida's** Engineering and Industrial Experiment Station since 1947 has resigned to accept a position with the **National Science Foundation.** Dr. Morgen's position with the National Science Foundation will be to direct the engineering and metallurgical phase of the program.

Fourteen post-graduate fellowships and 19 scholarships will be offered by the **Radio Corporation of America** for the 1952–1953 academic year under an expanded and revised scholarship program, Dr. C. B. Jolliffe, Vice President and Technical Director of RCA, announced. Total amount of the awards, according to Dr. Jolliffe, will be $53,000, a substantial increase over previous years. This amount reflects RCA's expanded program of helping young engineers and scientists by means of seven new scholarships and one fellowship. It was also pointed out that the annual stipends for RCA Scholarships have been increased from $600 to $800.

Section Meetings

Section	*Location of Meeting*	*Dates*	*Chairman of Section*
*Allegheny	West Virginia University		C. H. Cather, West Virginia University
Illinois-Indiana	Rose Polytechnic Institute	May, 16, 1953	H. A. Moench, Rose Polytechnic Institute
Kansas-Nebraska	University of Kansas	Oct. 24–25, 1952	M. A. Durland, Kansas State College
Michigan	Detroit Institute of Technology	May 9, 1953	C. C. Winn, Detroit Institute of Technology
Middle Atlantic	Manhattan College	December 6, 1952	W. B. Plank, Lafayette College
Missouri	Washington University	April 11, 1953	G. F. Branigan, University of Arkansas
National Capital Area	Catholic University of America	Oct. 7, 1952	L. K. Downing, Howard University
	Howard University	May 9, 1953	
	University of Maryland	Feb. 3, 1953	
New England	Worcester Polytechnic Institute	Oct. 18, 1952	E. T. Donovan, University of New Hampshire
North Midwest	Iowa State College	Oct. 3–4, 1952	S. J. Chamberlin, Iowa State College
*Ohio	University of Cincinnati	April, 1953	H. K. Justice, University of Cincinnati
*Pacific Northwest	Washington State College	Spring, 1953	J. P. Spielman, Washington State College
Pacific Southwest	California State Polytechnic College	Dec. 29–30, 1952	C. E. Cherry, College of Marin
*Rocky Mountain	University of Wyoming	April 19, 1952	C. A. Hutchinson, University of Colorado
*Southeastern	Louisiana State University	March, 1953	D. V. Terrell, University of Kentucky
Southwestern	University of New Mexico	April 3 & 4, 1953	M. L. Ray, University of Houston
Upper New York	Alfred University	October 10–11, 1952	R. M. Campbell, Alfred University

Members of the Society are welcome at all Section Meetings

* No Date Set.

AMERICAN SOCIETY FOR ENGINEERING EDUCATION

April 6, 1952

To Members of the General Council

Gentlemen:

Your Committee on Improvement of Teaching, authorized by action of the Council at its meeting of June 24, 1949, at Rensselaer Polytechnic Institute, was first organized as a steering committee during the summer of 1949 and later, in the summer of 1950, was constituted in its present form. There have been two meetings of the full membership, and each of its three groups have held meetings of their own. Important and closely coordinated work has been carried out through the institutional committees, which were organized in over one hundred colleges and universities. More than 150 reports and criticisms have been received from these local committees. These communications have clearly illustrated the many active reviews of teaching methods and the efforts being made to bring about improvements. Your central committee is greatly indebted to these institutional groups for their participation, criticisms, and suggestions.

We believe that this cooperative effort between the schools should be a continuing enterprise and that it should be a primary activity of the ASEE Division on Educational Methods. We recommend that the matter of continuation of the process of improvement of teaching be referred to that Division for study and action, and we further recommend that, with the presentation of this report, the Committee on Improvement of Teaching be discharged.

Sincerely yours,

L. E. Grinter, *Chairman*

H. H. Armsby
A. B. Bronwell
H. W. Barlow
J. F. Calvert
J. W. Cell
N. A. Christensen
A. P. Colburn
N. W. Dougherty
E. E. Dreese
C. G. Duncombe
R. Eliassen
W. L. Everitt
R. E. Fadum
L. E. Grinter
H. P. Hammond
G. A. Hawkins
T. J. Higgins
E. Hutchisson
R. R. Jenness
R. A. Kliphardt
F. C. Lindvall
L. C. Maugh
K. B. McEachron, Jr.
B. V. Moore
P. Nudd
S. P. Olmsted
F. H. Pumphrey
H. S. Rogers
T. Saville
J. F. Smith
H. L. Solberg
R. L. Sweigert
B. R. Teare
H. Torgersen
M. Tribus
E. A. Walker
E. Weber
J. G. Woodburn

Improvement of Engineering Teaching

Report of the Committee on Improvement of Teaching

I. SUMMARY

This study was designed to bring about discussion of teaching methods and ways of learning in engineering faculties throughout the country, and to present in report form a number of the factors believed to be important in the improvement of teaching. The primary objective of this study has been to consider how to prepare students to meet new situations with skill, resourcefulness and leadership. Such preparation requires of the staff an understanding of the principles of teaching and learning, an appreciation of means for developing resourcefulness and originality, and continuing study of the most effective ways to achieve coordination of instruction.

Other objectives have been to consider how to instill in the student the desire to continue to learn after graduation, and how to provide a cultural foundation which will encourage him to contribute to his local community and to civic groups as a mature, thinking, human individual. The findings presented represent the opinions of many in engineering teaching.

Principles of learning stress the importance of effective participation on the part of the learner; his motivation through the formulation of a goal; the clear definition of task assignments (preferably defined by the student himself); the evaluation of his progress; and his repeated practice in application. To raise the level of what the student does, it is emphasized that teaching should be from basic laws of science rather than from relatively specialized derived formulas. To a great degree, problems should involve the application of basic laws to real situations, and require student initiative in attack. Many of the basic laws apply in a number of engineering fields, and important opportunities exist for stressing these interrelated applications.

Much more attention can be given profitably to the development of the student's originality and resourcefulness in order to prepare him for the thought processes required in professional work. In the report, techniques are suggested for the development and presentation of new and unfamiliar situations in the shop, classroom, and laboratory. Consideration is given to seminars, elective courses, independent studies and to research experience. The project method of instruction, utilizing problems of comprehensive scope, is advocated as an attractive means of developing resourcefulness, and of implementing effective student activity. This method places the student more on his own responsibility and gives him experience in planning in contradistinction to the execution of prescribed operations.

Engineering education provides the opportunity for related approaches in classroom, laboratory, and design work. Full opportunity should be taken to coordinate these approaches. Similarly, the social-humanistic stem can become more meaningful to the engineering student by coordination with the technical studies. The rotation of instructors among the various subjects which come within their general professional field is recommended. Intelligently employed, this practice develops broader acquaintance with subject matter and promotes course coordination.

The teacher is the key factor in efforts to improve education. This should be fully appreciated by every administrative officer and should find expression in three major ways: (1) recruiting the most promising teachers; (2) recognizing good teaching in the most effective manner—advancement and adequate compensation; and (3) developing a specific plan for

staff and committee discussions on methods of improving teaching so that the young instructor may benefit from the experiences of mature staff members.

Teaching loads should be kept within prescribed limits in order to permit teachers at all levels to engage in creative research and other activities contributing to their professional development.

The present concerted movement to improve the quality of engineering instruction should be a continuing effort, and the Committee suggests that institutional committees be a continuing activity under the guidance of the Educational Methods Division. In addition, special schools might well be established for the specific purposes of aiding engineering teachers in the improvement of their methods of instruction and in the development of new methods through research and experiment.

II. INTRODUCTION

The study on which this report is based originated from the belief that while two comprehensive reports by committees of the Society—*Aims and Scope of Engineering Curricula* (1940) [1] and *Engineering Education After the War* (1944) [2]—have influenced engineering education by stating its fundamental objectives and recommending better means for attaining them, the findings of these earlier reports could become widely effective only if they would influence directly the center of engineering education—the student and teacher in the classroom. The Committee on Improvement of Teaching, which presents this report, was appointed to aid in accomplishing this result. The fundamental method of the Committee has been to stimulate discussion of teaching methods and their betterment in institutions throughout the country. More than one hundred faculty committees were appointed for this purpose and more than 150 reports, comments, and suggestions have been received.

This Committee has previously issued two preliminary reports based in large measure on the communications received from local faculty groups. These two reports have been circulated to all accredited engineering colleges throughout the country where they were discussed and criticisms were formulated. The responses are notable for frankness and discernment both with reference to local conditions and also to general conditions prevailing throughout engineering education. This final report is based to a very considerable degree on the communications received from the faculty discussion groups. It is this Committee's opinion that a wise college adminstration will find ways to expand the influence of these discussion groups to include a larger proportion of the engineering faculty, particularly the younger members.

It is vitally important that each institution decide how to place emphasis upon those factors that influence the quality of teaching. The first requirement is that the president, dean, and department heads value good teaching and make this fact known. They carry the responsibility for counselling with their staffs regarding the effectiveness of teaching. How this may be done best is a local problem and a matter of individual judgment.

Discussion groups appointed from young teachers, from departmental faculties, from the faculties of related departments, from teachers interested in laboratory instruction, from those with special interests in written or oral expression or from teachers drawn together by any common interest can have a vitalizing influence upon faculty morale and the effectiveness of teaching within the institution. Since many group interests may be encouraged and since faculties change continually, discussions on improvement of teaching should be made a live part of the continuing operation of every engineering faculty.

[1] *Journal of Engineering Education*, Vol. XXX, No. 7, March, 1940.

[2] *Journal of Engineering Education*, Vol. XXXV, No. 1, September, 1944.

III. OBJECTIVES OF ENGINEERING EDUCATION

Engineering education has been variously described as a profession, an art, a science, and a business. It is all of these, but primarily it is the profession in which men apply the known principles of the physical sciences creatively for the general good of society. The objectives of engineering education can be summarized as follows:

(1) To develop the student professionally so that he can make distinctive contributions to the welfare of society. An engineering student must be prepared continually to face new problems which call for skill, initiative, and leadership. He must project from past experience into new situations and must do so both with a sense of responsibility and with confidence in his ability to find an acceptable solution. Thus, with technical ability must be coupled economic judgment and an appreciation of social values conditioned by the specific requirements of the problem.

(2) To instill in the student the desire continually to progress professionally and to expand his knowledge and abilities. Professional progress may be achieved in any one of several directions, such as research, development, design, production, construction, sales, or education. Each requires a different emphasis of formal or informal study after graduation. The student should be guided to recognize his strengths that he may cultivate them, and his weaknessses that he may endeavor to overcome them.

(3) To provide a cultural foundation which will enable the student to comprehend economic and social problems and which will encourage him to contribute constructively to his local community and to civil groups as a mature, thinking, human individual.

In sum, the purpose of engineering instruction is epitomized in the statement by Warren K. Lewis, who said, "Our objective is the development of the capacity of the student when faced with a new and unfamiliar situation, to handle it with competence involving skill, initiative, and leadership."

IV. PRINCIPLES OF TEACHING AND LEARNING

A. Principles of Learning

As background it may be well to bring together a number of the basic principles of learning. A few are listed here for convenience:

1. *Learning is a process by which increasing ability is developed through the effective activity of the learner.* The learner must think through the idea to be understood, or perform the act in which he is to develop skill. Learning is not a passive process of absorption, but comes only through active participation. The lecture method of teaching all too often reduces the student to the role of an inactive observer, whose mental processes labor along at subnormal efficiencies. The zest and enthusiasm engendered by active participation in live problems are often much more effective in developing the student's potential capacities.

2. *The learner must have a goal.* Learning takes place only when the learner is trying to reach an objective. He must be motivated. The more desirable the goal, the more immediate and realistic it is, the stronger is the motivation to learn.

3. *Objectives for task assignments should be as clear and as immediate as possible.* The goals or objectives to be achieved and the lesson assignments or tasks should be clearly defined. The objectives should not be merely some distant or vague goal, but should be as definite and as immediate as possible. This does not mean that the specific steps or the methods of procedure are to be given. Part of the assignment might well be to require the student to define clearly his own goals before proceeding in the solution of the problem.

4. *The learner must know wherein he succeeds or fails.* Since, for effective learning, the student must *strive* to solve a problem or to acquire knowledge and skill, he must know promptly what progress he has made and precisely where he has failed. Routine drill without knowledge of results destroys zeal for learning. The good elements of a product should be recognized and praised, and only the specific defects, rather than the whole, should be adversely criticized. Fewer assigned problems, but all of these more carefully prepared and corrected, result in better learning. There are inherent values in having the student identify his products as his own creation. It is quite instructive for the student to evaluate, regularly and critically, his own degree of success or failure.

5. *True education requires understanding and mastery of the material to be learned.* This means insight into the fundamental laws or principles and proceeding from them to the formulas applying to a particular situation. Insight is developed by proceeding from the known to the unknown, from old concepts to new ones, from simple problems solved by one principle to complex problems involving more than one law or principle. This develops solid growth, insight and power in the use of basic principles, it gives to the student confidence, and it leads to initiative and originality in meeting new situations.

6. *Repeated practice in different applications is essential.* Repeated successful practice is better than fewer prolonged learning periods. A new idea should be repeated several times in different relationships and applications. These repetitions should not be routine, but each should reach a successively higher level.

B. Mastery vs. Coverage

Engineering is not easy. For success it demands hard, purposeful work. Resourcefulness, and at times, inspiration, are needed, but for continuing professional success there must always be present the ability to work hard, intelligently and purposefully.

The Committee believes, however, that in engineering education entirely too much time is spent on profitless, repetitive, routine assignments. This is not to say that practice is not needed to develop skills, but rather to suggest that a close survey of curricula will disclose time spent that might be better devoted to other purposes. In particular, the question may be asked whether a good many so-called problems really are problems in the sense that they require constructive thought and the development of judgment. All too often they merely require the following of a pattern of solution already illustrated or the substitution in a formula already derived.

Under pressure to cover ground, all engineering curricula have been so designed that they require the student to pursue knowledge and ability simultaneously in a considerable number and variety of subjects. Often this is done at some sacrifice of thoroughness, mastery of fundamentals, training in accuracy, or the development of facility for written and oral expression. Improvement needs to be made by concentrating the student's efforts on a smaller field of coverage, in order better to develop his command over fundamental laws and their uses, to increase his resourcefulness to face new and untried situations, and to improve his ability to express himself. In a word, to do less but to do it better is a desirable aim of engineering education for the immediate future.

C. Teaching from Basic Laws

The terms "basic laws" and "derived formulas" are relative rather than absolute. Generally speaking, basic laws are the mathematical statements of fundamental scientific principles. Derived formulas, developed from the basic laws, often apply only to limited areas of engineering practice. The basic laws commonly employed in any given area of en-

gineering are not numerous, and are the true building blocks of engineering, both at the educational and the professional levels.

Insight into the basic laws and their physical meaning can be of inestimable value since it helps the student gain a sound conceptual understanding of his engineering subjects. Basic laws are also indispensable to the engineer in dealing with new problems. As the engineer achieves professional stature, the old laws will take on new meanings and he will learn new basic laws, which, combined with the old, will give him a deeper insight into the foundations of engineering than is possible even from an extensive knowledge of derived formulas. These derived formulas and accepted practices so necessary in specific engineering applications should be derived, whenever possible, from the basic laws of science.

It follows that problem assignments should, in so far as possible, require the student to arrive at conclusions by the use of basic laws. It is also instructive to assign problems in which the student derives or extends the applications of one of these laws. It may be worthy of mention that numerical or graphical solutions may often proceed directly from basic laws to end results without need of derived formulas as an intermediate step of analysis.

Many of the principles which we consider basic in engineering today existed only in the realm of pure mathematics or physics a quarter of a century ago. In view of the spectacular progress being made in physics and engineering, it seems inevitable that new basic laws will be introduced in the undergraduate curriculum in the years to come. It is the responsibility of the instructor to seek these out and to present them to the student in understandable and usable forms.

Closely related to the need for emphasis on basic laws is the importance of coordinating the subject material of various engineering courses through their employment in many parts of the curriculum.

D. Engineering—An Expanding Body of Knowledge

Engineering and science should be taught as a dynamic body of knowledge, which is constantly expanding. Students are vitally interested in knowing something about the limits of present-day knowledge, the directions of expansion, and the probable frontiers of the future. An undergraduate course which conveys the impression that all knowledge of the subject is known and that there are no frontiers of development is sterile and uninteresting.

E. Student Participation in His Learning Process

Successful teachers give careful consideration to methods of stimulating interest and arousing the student's enthusiasm in the subject. These can best be developed by a method of teaching which brings the student into active participation in his learning process and which gives him ample opportunity to express his ideas. For example, the teacher might start the class by proposing a specific problem, to illustrate a fundamental principle, and then solicit suggestions from the students on methods of attack. This in all probability will result in a stimulating discussion with considerable zest and enthusiasm for finding a solution. This method serves to develop sound and logical thinking, ability for self-expression, and a high degree of motivation, since the student's rather than the teacher's ideas appear to be the focal points of the discussion. However, this method of instruction requires careful planning and skilful guidance if desired objectives are to be attained.

The principal limitation in the student participation plan is that it is difficult to maintain the same rate of progress as in the purely lecture type of course in which the instructor presents the material in an orderly, logical pattern. It may therefore be desirable to use both methods in appropriate proportions—the lecture

method, with some opportunity for informal student comment, to give a clear understanding of basic principles, and also the student participation method, to illustrate applications of these principles. This advances the student's knowledge rapidly yet permits him to develop both his individual capacities and his ability to contribute through group discussions.

Wherever possible, the problems should deal with real situations so that motivation is provided by a sense of accomplishment when a student reaches a conclusion. The problems should be directed also toward the goal of learning to deal with new situations, using basic principles, rather than merely in obtaining numerical solutions by use of derived formulas.

F. Training in Accuracy

Frequently students are not trained to develop habits of accuracy in their work. They should realize that mistakes involving life or dollars cannot be tolerated in engineering practice and that they must develop habits of accuracy not only in their initial computations, but must *always* check their work. They must learn also to size up their work to see whether, from the data and conditions, results are reasonable and that there is dimensional homogeneity throughout the quantities of an equation.

V. DEVELOPMENT OF RESOURCEFULNESS AND ORIGINALITY

At times we lose sight of the latent possibilities for creative work possessed by engineering students. There is evidence that all levels and kinds of creative ability may be found, and that through training directed to that end, the powers of an individual may be enhanced much more than is commonly supposed.

In a qualitative sense, perhaps *originality* is the best single word to describe the abilities with which we are concerned, though the terms ingenuity, inventiveness, and creativity are also descriptive of the qualities with which we are dealing. Resourcefulness, which is a characteristic of all successful engineers, is closely related to originality.

It is believed that the engineer will progress best if, before leaving college, he is given certain principles and practices related to original work. These will be concerned with alertness for the discovery of new problems and new facts and with facility for dealing with unfamiliar situations. He needs to develop: a method and habit for clearly stating objectives, idea fluency in proposing solutions, a skill for matching the probable results of such proposals against the desired objectives, and an ability to negotiate the acceptance of his ideas.

A. Steps in Creative Problem Solving

The practicing engineer is concerned with problems which do not come to him neatly packaged under the sequential heading of "Given" and "Find." He is concerned with the much more general arts of discovering and defining problems as well as with solving them.

Let us consider three questions:

(1) Where do problems come from?
(2) What do people do with them? and
(3) What should the engineer do with them?

A complete engineering problem calls for its statement both in terms of a human want and in terms of certain physical results. The latter become the goals which, if achieved, it is believed will satisfy the want. In endeavoring to solve a problem, the engineer may try to find a new combination of old ideas; or he may seek to discover new ideas or facts which, when appropriately combined, yield a desired result.

The four parts to engineering problem solving may be stated as follows:

1. *Discovering a Human Want* [3]

The statement of a problem is preceded by the existence of a human want. With the engineer this should lead to a kind of

[3] As used here, "want" implies many things of which physical goods may be only a single classification.

optimistic discontent. The engineer who does not have the urge to do things differently and better is not likely to invent. He should feel that he must state problems accurately and that he will find solutions if they are sufficiently justified.

2. *Statement of Goal*

In endeavoring to make a concise statement of a problem, one might start by listing all factors which seem to have a bearing on it. Through classification and consolidation, an effort should be made to extract from these factors a statement somewhat of the following form:

(a) The purpose is to produce (if a design is called for).....
or the purpose is to determine (if an analysis is needed).....
(b) To overcome the specific obstacles of.....
(c) in such a way that.....

Under item (a) could be listed a device or test. Under (b) could be stated any related restrictions. The latter might include undesirable features of the present-day situation or equipment. There might be, and often is, the question "Why do it this way?". It might also include difficulties to be encountered in negotiating the acceptance of a solution. Under (c) could be placed all manner of specifications. Besides the usual ones of cost, size, weight and performance characteristics, other criteria may be necessary in the initial stages of a development. Thus, if a hitherto unseen device or material is called for, a list of minimum acceptable criteria may be needed. However, if more than one set of physical results will satisfy minimum criteria, there may be required a weighted grading system concerned with how any or all sets of physical results exceed the minimum requirements. On such a basis the engineer decides which of several procedures he should carry forward.

3. *The Incubation Period*

Suitable combinations of idea elements for the solution of a problem usually do not just hatch. If the problem is difficult, this period will be one of great effort characterized by considerable frustration and indecision.

One of the greatest difficulties is that winning combinations are often too elaborate for the mind to include in a single span of comprehension. However, students should learn that if the necessary individual elements can be listed, a large problem may be reduced to a series of smaller ones which may be solved one at a time. A continuing effort so to reduce the major problem is a means of avoiding confusion and frustration.

Closely related to the foregoing is the fact that needed idea elements often are not brought forth because they are embedded in the memory of different situations where they were first learned and applied. The disassociation of such knowledge, so that the pertinent parts may be transferred to the new problem, represents a difficult feat. Correlation of courses in accord with basic laws gives a helpful background for the transfer of ideas. The ability to draw analogies is also a powerful device and its use may be developed. It may be desirable at times to take a rest from part or even all of the problem in order that useless ideas may fade out of one's consciousness.

Other common difficulties of the incubation period are:

(a) Presumed pertinent facts are only partially true, or even totally untrue. Those which are only partially correct seem to be the most difficult with which to deal.

(b) Perhaps not enough data are available to solve the problem.

(c) When a potential solution has been found, it is not time to stop; modifications and alternate solutions often can be found. Since engineering is a highly competitive field, it is important to look for the best solution, and also to stake out avenues for improvements which permit later development.

4. *Final Negotiations*

To capitalize on any problem solution, it is generally necessary to negotiate its

acceptance. Usually the young engineer is shocked to discover that he has not only to do the job, but to persuade others to accept his ideas; and at times he is more than shocked to find that the man who presented him with the original task is often his severest critic.

5. *Summary of Traits Required for Original Work*

The following personal characteristics and abilities seem to be essential for creative engineering accomplishments:

(a) Personal characteristics:
1. Active desire to achieve.
2. Optimistic discontent.
3. Directed curiosity.
4. Memory for basic facts and for the data pertinent to the present work.
5. Imagery—the ability to visualize in two and three dimensions, and in symbolic notations.
6. Logical thinking—to check for both matches and mismatches between the results of a given combination and those required by the stated goals.

(b) Abilities:
1. To state the problem.
2. To reduce it to a series of small goals.
3. To associate idea elements and to reevaluate the requirements.
4. To work hard, to discuss, etc., and to set the stage for the appearance of the winning combination even if this calls for the complete abandonment of the problem for a period of time.

B. Reflected Problems in Engineering Education

Problem work which calls for facility with new and unfamiliar situations should be included in the undergraduate curriculum. Motivation for such activity is an item of primary importance and a theme which should be carried through all four years of study. However, the abilities and work methods of the creative engineer can be broken down into components in such a way that many of the present college courses can be made to contribute much more than they often do to the development of the student's capacity for dealing with new and unfamiliar situations. The following are suggested as some of the curricular possibilities.

C. The Project Method

This is probably the most valuable of the methods that may be used to develop originality and resourcefulness.

By "project method" is meant the use of problems of more comprehensive scope than those of the usual type employed in introductory courses which involve only a single element or operation. Projects may range from simple situations which may be used to introduce the method in the lower years to those for more mature students which are of larger scale and more complex nature involving search for the principles involved. Only a few projects of major scope might be assigned in a semester. The undergraduate thesis or senior seminar paper should represent the culmination of this method of instruction.

In the project method, as in the solution of most engineering problems, the student is required to:

(1) Identify and define the whole problem.
(2) Plan the solution.
(3) Choose the analytical methods and tools of solution and carry out the plan.
(4) Test the results.
(5) Evaluate the process and draw conclusions.

1. *Educational Gains from Use of the Project Method*

The project method is more costly than the customary classroom-laboratory method in terms of student and instructor time and of laboratory equipment. If used to an appreciable extent it means also that the student will cover less ground

Failure to cover quite as much ground, provided the student will not lack essential knowledge, should not be considered adverse to the project method. The end result should be better mastery of fundamental principles and greater confidence and skill in their use.

The project method places the student more on his own responsibility than do methods of instruction more commonly used. The student must, of course, be given help when he really needs it. Some floundering can provide beneficial experience. A major purpose of the project method is to give the student a sample, even if a small one, of the way he will meet conditions after graduation. It is intended also to serve as a means of breaking the lockstep of work assigned in small daily installments from period to period and from examination to examination, a practice that often seems to extend from the time of entry until graduation.

The Committee believes that entirely too much of the student's time is consumed in repetitive, routine jobs. It is true that practice is needed to develop skills. However, a close survey of many courses would reveal that a substantial amount of time could be devoted more profitably to other purposes. In particular, the question might be asked: How much of the problem assignment deals with exercises which merely require the following of a pattern of solution already illustrated or the substitution in a formula already derived?

While the project method can be used to good advantage to give the student experience in original and creative thinking in probably every engineering course, the following provides a few specific examples:

2. *Drawing, Shop and Kinematics*

Courses in drawing, shop, and kinematics could contribute significantly by including problems which require the student to exercise resourcefulness and ingenuity in putting various elements together to get a desired solution.

It may be assumed that the development of a three dimensional sense will prove as valuable to the engineer as will knowledge of shop techniques and the language of drawings. It is not too difficult to achieve reasonable ability in isometric and perspective line drawing. Transparent models and freehand drawings by students, using color to illustrate the various parts, have great educational value. A substantial amount of material has been catalogued on devices and mechanisms. The design principles embodied in these devices often prove to be the building blocks for new equipment.

3. *Classroom and Computing Periods*

Occasional lectures which describe specific creative work may arouse students to a desire to make contributions of their own. Many examples can be prepared in any field to show how engineering problems arose, how they were broken down into smaller problems, the obstacles which were met and how they were solved, and how the results became accepted. However, it should be clearly recognized that the student can develop his own creative abilities only by coming to grips with problems in which he himself is trying to be the originator or creator.

A few problems might be employed which include too much information and others which contain too little. Again a problem might be introduced containing an error in the engineering diagram. These would be of value because discrimination and reasoned assumptions are commonly called for in uncharted areas, and each may require resourcefulness or originality.

4. *Laboratory*

Laboratory work may be employed to substantiate theory which has been presented in texts and lectures. If the philosophy is adopted that, after the techniques are learned, one of the prime purposes of laboratory work is to develop self-reliance and ingenuity, then a great deal may be accomplished. Examples may be cited wherein only the end results are specified and a squad is permitted to plan the test, select the equipment and carry

out its own program. By such a process fewer experiments and write-ups will be completed, but engineers will be produced who can do more than follow stereotyped cook-book instructions.

5. *Seminar, Elective Courses and Independent Study*

Courses such as these, coming as they usually do in the senior year, may be designed explicitly to encourage originality. However, except for a small percentage of the students, neither enthusiasm nor results should be anticipated unless the students have been prepared for this sort of work during their earlier years of study. It is imperative to give the individual student broad latitude in selecting his own goals in order that he will develop the interest and drive necessary to carry such work to a successful conclusion.

6. *Research Projects*

It is often desirable to place promising undergraduates on full scale projects where they may assist staff members who are engaged in research. Much can be accomplished provided that intelligent attention is given to educational possibilities. The changes in viewpoint and the reasons for decision should be made quite clear to the students in order that they may learn to discriminate, to cut through the non-essential matters, and to develop engineering judgment.

VI. COORDINATION OF INSTRUCTION

An asset of engineering education is the opportunity to use several methods of instruction in a given field. Methods commonly employed are: the lecture-recitation procedure, which is used chiefly to aid the student in obtaining an understanding of basic laws; laboratory work, to strengthen such understanding and also to develop skill in experimental techniques; and design work, which is used both to show how engineering principles are applied in situations simulating practice and also to illustrate how principles from related fields can be combined to yield a solution.

A. Coordination between Engineering Courses

Coordination of methods of instruction means conducting courses in such a manner that the student sees the relationship between a subject as it is studied in the classroom and as it is applied in the laboratory or in design. In a single subject it is desirable to have recitation and laboratory work either simultaneously or in a planned sequence so that the student applies principles soon after he has studied them theoretically. This brings to him both a better understanding of the theory and a better appreciation of the limitations surrounding its use.

The opportunity to realize these aims varies with courses. The optimum realizable coordination of class and laboratory work probably occurs in chemistry, with physics and mechanics in nearly as favorable situations. In such courses as heat engineering and unit processes, which employ complex fixed equipment, it is more difficult to achieve close coordination. However, opportunities exist in courses even of the latter type to use relatively simple inexpensive equipment that may be duplicated to achieve better coordination with classroom work. When such equipment is used, the experimental work often can aid the student in mastering principles to even greater advantage than is possible with the more elaborate equipment.

Most of the major engineering laboratory work employs subject matter covered much earlier in preparatory courses. Numerous examples of this are to be found in chemical engineering unit operation laboratory courses. In these it is necessary that the work be so taught that the students will see clearly the relationship of the experiments to the principles previously taught either in the same or other departments.

One of the better opportunities for coordination lies in the field of materials of engineering. Recitations, laboratory and

design all consider the use of materials in machines, in process equipment, and in structures. Basic studies of materials occur in the shop, the materials testing laboratory, the course in strength of materials, and courses in metallurgy. Hence, instruction in materials is given in separate segments, yet not often as related parts of a major field. Here exists an opportunity for the instructor and student to realize that portions of the subject material in many courses form parts of the whole field of engineering materials.

B. Coordination with Humanistic-Social Courses

The foregoing relates expressly to coordination within the scientific-technological stem of the curriculum. There are opportunities to improve coordination of the technical and scientific with the humanistic-social courses. An example is in developing the art of expression. Students are most likely to understand and be impressed by the necessity for the use of clear expression if it is required in their engineering courses, and if they learn that sloppy writing or speaking is a serious handicap in engineering practice. Engineering curricula, because they require a great deal of report writing, offer many opportunities for additional training. Correction of faults in oral presentation in the classroom is as important as correction of written papers. But it should be emphasized that engineering teachers must take the prime responsibility for the good written and oral expression of their students.

There are also opportunities for the coordination of other humanistic-social subjects with scientific and technological subjects. Economics is one of these. As an example, every teacher of engineering knows that the advent of heat power as a means of doing work brought on a revolutionary change in our whole economic and social organization. There are opportunities to introduce many specific examples which show the impact of technology upon our present-day social-economic system and thereby to impress the student with the significance of his studies in economics.

However, in the attempt to achieve correlation, we should not expect to distort the studies of our students in the social science and humanities so that these become modified engineering courses. The social science and humanities courses are, in their own right, vital parts of the engineer's education. Their function is to give the student a mature viewpoint, gained through an increased knowledge of cultures and civilizations; an understanding of social and ethical concepts and their effects upon the present-day world; an insight into the origin and functioning of social and industrial institutions; as well as an understanding of economic principles in modern industrial society. They provide experience with different procedures for collecting data and different reasoned approaches to conclusions. They offer opportunities for enriched intellectual lives through the development of individual cultural interests. Any attempt to channel such courses into purely engineering areas will deprive our students of essential opportunities for development.

C. Educational Function of Examinations

It is often assumed that the major purpose of examinations is to evaluate the performance of students. Examinations do, of course, serve the purpose of keeping the student aware of the quality of his work and of acquainting him with his mistakes and weaknesses. The results of an examination may also acquaint the instructor with his own shortcomings as evidenced by his students' work. But these are only some of the values; if properly planned, examinations serve other important educational purposes. They can stimulate the student to review the course, thereby achieving a better organization in his mind of the subject matter. They place the student on his own responsibility and require him to think for himself. If so prepared, they may require him to use more than a single principle to solve a

problem and thus to synthesize his knowledge.

If administered by the open-book plan, examinations may require the solution of fairly comprehensive problems in which the student must bring to bear and hence correlate his knowledge of principles and data from more than one field. Examinations of this type will require a generous time allotment and some preparatory conditioning of the student, but they have educational value well beyond those used merely to inventory the student's knowledge. Open-book examinations are best adapted to upper class subjects but are not necessarily so limited. Teachers who have employed such examinations usually are convinced of their value as an integral part of the program for student development.

D. Rotation of Instructors

While practice differs, there is a tendency among departments to confine an instructor's work to a small group of related courses and to leave him on such a set of assignments indefinitely. This does not give him an opportunity to broaden either his technical interests or his evaluation of the program of the school as a whole. Also it does not bring to a given subject the benefits of fresh points of view. It is recognized that each department must have specialists, particularly at the higher levels, but some of these men might also enjoy the opportunity to "renew their youth" scholastically by teaching an introductory course from time to time. It is believed that there would be definite advantages in rotating instructors among the several introductory courses of a department, and even to extend this practice beyond departmental lines.

One of the best ways of achieving correlation of subject material in various courses is to rotate teachers among the courses that each may acquire a better overall picture of the structure and content of the curriculum. Ideas soon develop on how the material can be better correlated.

VII. DEVELOPMENT AND GROWTH OF TEACHERS

The teacher is the key factor in the efforts to improve teaching. Every administrative officer realizes his responsibility to recruit and retain a strong faculty. It is equally important for the dean and department head to aid his faculty to increase in effectiveness by individual and collective efforts; to provide opportunities for leaves of absence for advanced study or industrial employment; to provide opportunities for research; and in general to create an atmosphere favorable to progress. It is very important that there be a definitely understood policy to reward achievements in effective teaching.

A. Organizing an Engineering Faculty for Improvement of Teaching

Continuous organization for the improvement of engineering education should be a normal faculty function. It is believed that the value of the work of the institutional committees, whose contributions are so largely reflected in this report, bears out this claim. Such organizations may take several forms. Through formal meetings younger staff members may meet with the dean, department chairmen, and senior staff members. Members of the staff of the School of Education should be invited to present some matters of basic importance to teachers. Informal meetings of staff members may be instituted for the discussion either of problems related to specific courses or for the consideration of more general educational problems. Successful teaching is a skilled art, and one in which the new instructor can profit immeasurably from the experiences of others.

Somewhat less formally organized methods may be employed. A practice sometimes used is to assign a younger teacher to an experienced faculty member, so that the younger man may audit a course, follow the methods employed and thoughtfully consider the development of his own procedures. In addition it may be well for a younger teacher to invite a more ex-

perienced staff member to audit his work in order that the young teacher may gain from suggestions and constructive criticism.

The benefits of cross fertilization are well recognized. Visiting professors should be sought—particularly those who are known to be excellent teachers and those who have new methods or new material to present. They afford other staff members the opportunity for auditing and observing. The use of men from industry, who come to the colleges either for short or for extended periods of time, may bring to the colleges fresh view points. The latter procedure may have much the same value as the experience which staff members gain through part-time employment in a single industrial department.

The scheme of encouraging the appointment of institutional committees for improvement of teaching, which has been promoted by this committee through ASEE, has proved useful because the institutional committee is formal enough to be recognized and still informal enough to work under its own initiative. The fact that there is a committee doing something about improvement of teaching will direct attention to the problem and stimulate interest in it. If these committees identify good techniques in each of the schools, a very considerable improvement may be achieved. The fact that more than a thousand engineering teachers have taken part in such formal discussions during the past year is a matter of great importance to engineering education.

B. The Development of Instructors

This portion of the report is based upon answers obtained to a number of questions submitted to a selected group of experienced teachers. The questions dealt with intra-departmental methods of developing young instructors and represent a cross-section of opinion and experience. It is to be noted that a significant number of institutions is making systematic efforts to assist the younger teachers to improve their work.

1. Frequent meetings are conducted during a term for both new and experienced teachers giving the same course. They gather to discuss objectives of instruction, methods of presentation, etc.

2. New teachers meet each week with an experienced teacher acting as chairman. They are likely to be teaching the same courses and take turns presenting some of the material of the next week's classes, while others criticize and ask questions. The senior member is chary of criticizing, but by means of questions brings out the fact that there are more ways than one to present the topic. This method induces very careful preparation several days before a given subject is introduced to the student.

3. New teachers are encouraged to bring their teaching problems to senior members. Each junior staff member may thus pay weekly visits to a senior member for guidance and counsel. The senior member may be assigned by the chairman of the department, or he may be chosen by the junior member. The new teacher needs a maximum amount of encouragement, and a minimum of supervision.

4. The work of the new teacher is regularly supervised by a senior member. Together they plan and discuss the weekly schedule of material, quiz making, and methods of grading. They may also arrange to exchange class visitations.

C. Recognition of Good Teaching

As a fundamental policy, too often not observed, good teaching should be recognized and rewarded. Rewards should include the tangible form of promotion and increase in salary. Good teaching is not always accompanied by research or publications, though these are earmarks of a progressive spirit that is often reflected in inspired teaching. It is very important that it be known universally among staff members that good teaching *per se* is watched for and will be recognized and rewarded just as is authorship and research.

If many of the improvements of teaching that are advocated in this report are

to be adopted, both teaching and study loads must be held within limits that will permit instructors to devote sufficient time to the development and broadening of their experience. This remark does not apply to research in institutions that systematically compensate for time so applied by proportionally reducing teaching loads, but it does apply to excessive teaching loads, either as measured by number of class hours per week or by number of students per instructor or both. General observation supports the conclusion that, in general, teaching loads in engineering are too heavy either as measured on a scale involving amount of time available for constructive improvement of teaching or in comparison with other fields of instruction.

VIII. RECOMMENDATIONS

A. Continuation of Committees

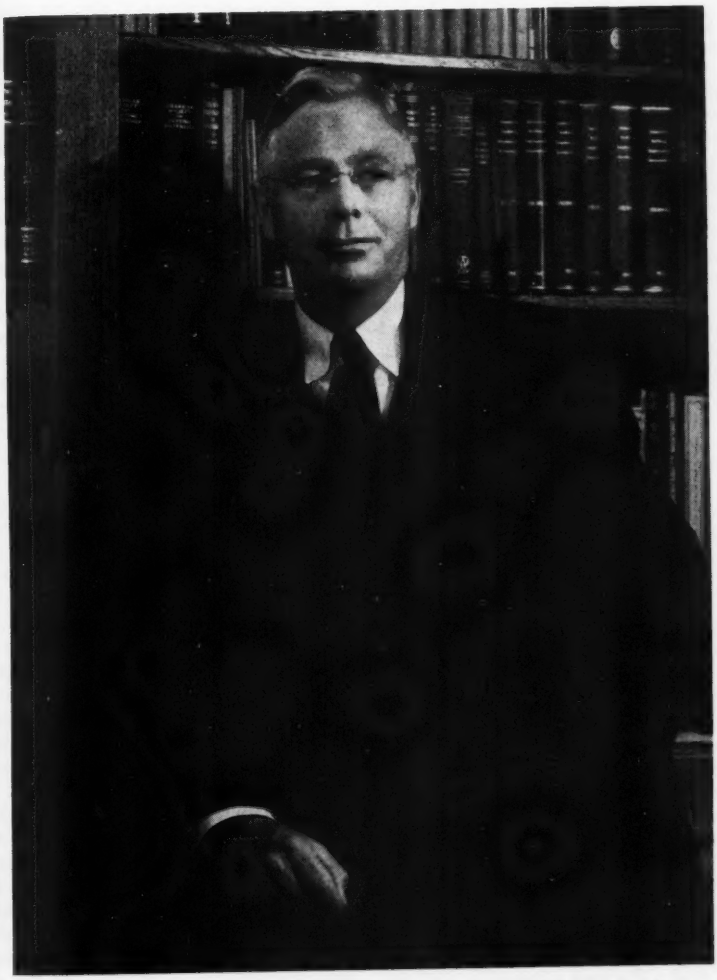
This Committee recognizes that a concerted movement to improve the quality of instruction in engineering colleges must be a continuing effort. The success of the present program to enlist the cooperation of faculties throughout the country lends much encouragement to the hope that this undertaking may continue during many years to come. Engineering teachers agree that teaching can be improved. Engineering education is not static; it is dynamic. Constant changes in science and in the art of engineering practice bring new requirements and opportunities. It is important that these efforts at self-appraisal continue, and it is even more important that they should be reflected by continuing efforts to bring about improvements in the real center of engineering education, which is the classroom.

This Committee suggests, therefore, that institutional committees, such as were appointed to cooperate in the preparation of this report—possibly with rotating membership—be a continuing function of each engineering college. It also recommends that each engineering college adopt for itself a definite plan to assist the young teacher in developing more effective teaching methods achieving professional growth. These factors are far too important to the institution to be left to unguided chance development.

B. Schools for Engineering Teachers

As an additional recommendation, this Committee proposes, in accordance with suggestions from correspondents, that special schools or postgraduate training programs for the specific purpose of aiding teachers to improve their methods of instruction be established in strategically located institutions. These postgraduate programs must have strong staffs in engineering, science, and the humanistic-social studies relating to engineering, as well as teachers either from faculties of education or selected from the engineering group because of their known skill in teaching. It is hoped that if such schools can be established, means can be found for aiding teachers financially so that they can attend for an academic year. One possibility is that of granting a leave of absence with salary; another is the subvention from an educational foundation. It is suggested that the sponsoring institutions offer academic credit and a suitable advanced degree for successful completion of the program. Programs combining such work in education with subject matter courses in engineering or administration would serve a very useful purpose. Opportunities must be provided for suitable research which may be related either to educational methods, the correlation of knowledge, in addition to the more conventional types of work in specialized areas of engineering and applied science.

Lamme Award—1952—Solomon Cady Hollister



To SOLOMON CADY HOLLISTER *for his excellent work in stating the functions of engineering education and his dynamic leadership in putting them into practice; for his untiring efforts in bringing to public notice the great need for engineers and the necessity for using them to their greatest efficiency; for his achievements as a teacher, a consulting engineer, a research worker and an engineering educational administrator, we award this the 25th Lamme Medal.*

SOLOMON CADY HOLLISTER was born in Crystal Falls, Michigan, on August 4, 1891, the son of Solomon Davis and Mary Runkel Hollister. The family moved westward to the State of Washington in his early youth, bringing to him an experience that still holds many vivid memories. Although his career has brought him again to the East, many of Dean Hollister's associates will credit him with a Western viewpoint—full-scale and distinctly three-dimensional.

His collegiate training started at the State College of Washington and was continued at the University of Wisconsin, where he received the B.S. in C.E. in 1916 and the C.E. in 1932. He was awarded the honorary degree of Doctor of Engineering by Stevens Institute of Technology in 1942, and is being similarly honored this year by his alma mater, Wisconsin, with the Doctor of Science degree.

For a period of some fifteen years after graduation Dr. Hollister engaged in a wide range of professional practice, including an initial venture in the academic world as an instructor in mechanics at the University of Illinois in 1916–17.

It was at this time that reinforced concrete construction was emerging from the status of a somewhat unpredictable art to that of a structural science. Dean Hollister soon became associated with several of the major activities in this field. By 1918 he was a member of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete, and in 1919–20 he served as chief design engineer and head, Investigation Branch, Concrete Ship Section of the U. S. Shipping Board. Although his career has since taken him into various other engineering interests, he has maintained a close affinity with concrete technology as a teacher, consultant, and member of numerous technical groups in the field. His long association with the American Concrete Institute includes several committee chairmanships and two terms as president, 1932–1934.

Of his many publications a good number deal with concrete and structural design, including an A.C.I. Wason Research Medal paper on the design and construction of a skew arch bridge.

As a consulting engineer in the 1920's he became interested in the potentialities and problems of structural welding. He undertook the development of the more vigorous methods of stress analysis and engineering control required in welded fabrication. This interest, in turn, led him back to the academic scene in 1930, when he was appointed Professor of Structural Engineering and Assistant Director of the Testing Materials Laboratory at Purdue. His work on photoelastic methods of analysis led to his appointment as consulting engineer to Babcock and Wilcox on the design and fabrication of the Hoover Dam penstocks. He has since carried out a number of assignments for this company on high pressure boiler design. Other consulting activities with industry and government agencies have covered a wide range of engineering problems. During this period he also conducted research on the transit mixer which became the basis of specifications for concrete mixed in this manner.

In 1934 he came to Cornell as Director of the School of Civil Engineering, and in 1937 he was appointed Dean of the College of Engineering. He has since devoted much time to educational development, and particularly to the relation of engineering education to the profession. At Cornell, the five-year undergraduate engineering curricula are one expression of the resultant philosophy.

His years at Cornell have been both challenging and rewarding. He has won the enthusiastic support of the alumni, and this, coupled with the will of his colleagues on the campus, has made possible both educational advancement and physical development of considerable magnitude despite the disruption of the war years.

Since his association with the academic world, Dean Hollister has had an increasing range of opportunity for stimulating service to engineering education. Among his major responsibilities in recent years

have been the chairmanship of the Education Committee of Engineers' Council for Professional Development; also of the Subcommittee on Graduate Education and of the Committee on Adequacy and Standards, all in E.C.P.D. During this period these committees have issued several reports which have been widely discussed as guideposts to a new era in engineering education, specifically—"Differentiating Characteristics of an Engineering Curriculum," "Report on Graduate Education in Engineering," and "Adequacy and Standards of Engineering Education."

Dean Hollister's advocacy of a stronger engineering profession through advancement of education has had a companion crusade for some years—that of maintaining an adequate supply of engineering manpower for the technological developments ahead. He is a member of the Manpower Commission of Engineers' Joint Council; of the Committee on Specialized Personnel, Office of Defense Mobilization; and of the Advisory Committee on Engineering Sciences for Selective Service. Recently he has also been appointed to the Advisory Committee for the National Registry of Engineers and Scientists.

He has had long association with ASEE, starting with his first instructorship in 1916, including various committee memberships and chairmanships, and culminating in the presidency of the Society for 1951–52.

Dean Hollister has had many other associations with professional, educational, and governmental organizations, and many continue active. His deep interest is in the advancement of the engineering profession and in stimulation of the educational means toward this end. His efforts as teacher, administrator, and spokesman have focused on this point.

College Notes

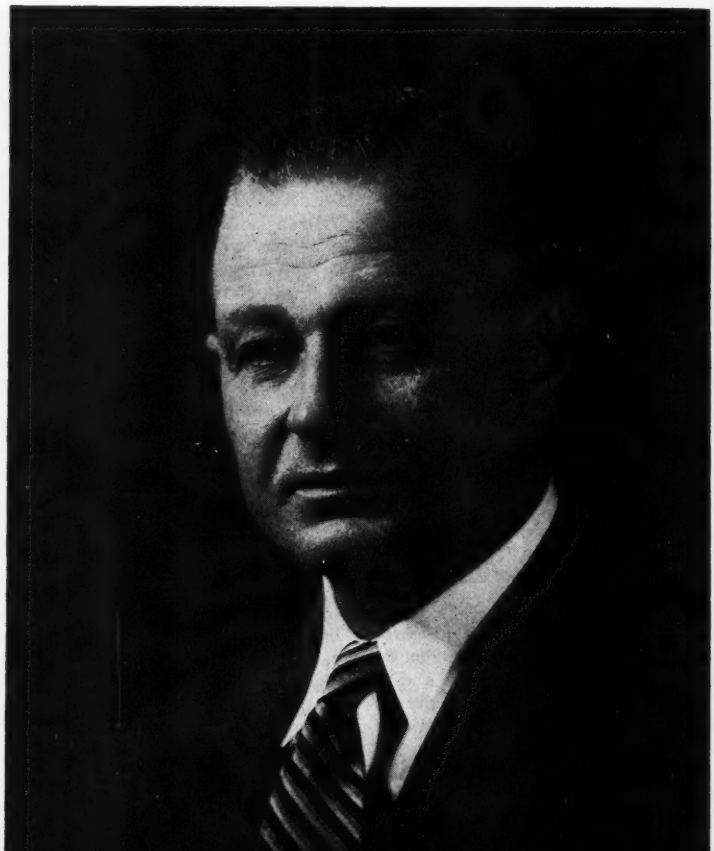
The Division of Cooperative Research, an important top-level link between **Columbia's** new Engineering Center and industry, has been activated with the appointment of Dr. John G. Dean, widely-known research scientist, as Director.

By order of President Truman, Dean S. S. Steinberg, **University of Maryland** College of Engineering, has been awarded a Special Certificate of Merit. The presentation was made by Secretary of Labor Maurice J. Tobin with the citation "for his outstanding contribution as Chairman of the Committee on Education of the President's Conference on Industrial Safety, in grateful appreciation for his performance of duties important to the public interest."

A grant of $150,000 has been made by the Carnegie Corporation of New York to **Case Institute of Technology**, Cleveland, Ohio, to aid in development of an experimental program for liberalizing engineering education which was begun at Case three years ago. The grant will be paid in five equal annual installments beginning this year, said Dr. Elmer Hutchisson, acting president of Case, in making the announcement.

W. J. Cope has been appointed Chairman of the Department of Mechanical Engineering at **Swarthmore College.** Dr. Cope comes to Swarthmore from the **University of Utah** where he has served for the past several years.

George Westinghouse Award—1952—
Gordon S. Brown



To GORDON STANLEY BROWN *for his invaluable work in the development of the science of automatic controls; for his books, technical papers and participation, nationally and internationally, in scientific conferences for the dissemination of technical information in a new field; for his effective contribution to undergraduate education, graduate education and research; for his inspiring guidance in the thinking and outlook of students; and for his influence on his fellow workers, we award this the 7th George Westinghouse Award.*

DR. GORDON S. BROWN, born in Australia in 1907 and naturalized as a U. S. citizen in 1939, was educated at Melbourne (Australia) Technical High School and M.I.T., receiving from the latter institution the Bachelor of Science degree in 1931, the Master's degree in 1934, and the Doctorate in 1938.

Internationally known for his contributions in the field of servomechanisms, he has risen on the M.I.T. staff through the positions of Research Assistant in 1931, Assistant Professor in 1939, Associate Professor in 1941, and Professor of Electrical Engineering in 1946. Appointed Associate Head of the Electrical Engineering Department in 1950, he now serves as Chairman of the Faculty and as a member of the Institute's Academic Council. His latest recognition as an engineering educator was his selection as Head of the Electrical Engineering Department at M.I.T. to replace Dr. Harold L. Hazen, who was promoted to Dean of the Graduate School.

He stands out as a pioneer and leader of current progress in engineering education. He has, to a most extraordinary degree, the faculty of "getting under the skin" of even the most retiring student. His style is completely that of the shirt-sleeves-rolled-up, personal participant in whatever is going on. This means that his influence is direct and personal. The full force of Brown in teaching becomes clear only when one combines his internationally recognized professional stature with his deep interest in students, with his uncanny personal ability to make intimate and forceful intellectual contact with them, and with his consequent ability to inspire them with his dynamic enthusiasm and breadth of outlook.

Few students can be members of his class without responding actively to the challenge he puts forth. His power lies not so much in refinement of technique or nicety and elegance of exposition, but rather in the vigor, perspective, range, and interest of illustrative example, and in his insistence upon getting to the heart of a problem. As an Honors Group Counsellor early in his career, Brown faced one of the most difficult tasks that an undergraduate teacher can encounter. Such a challenge found Brown at his best, and his performance as Honors Group Counsellor was outstanding.

At the opening of World War II, M.I.T. had the only university servomechanisms laboratory in the country. Laboratory Director Brown and his colleagues (many of whom were graduate students) at once undertook a program of research for the armed services that contributed notably to successful prosecution of the war. Since the war the laboratory has been engaged in research of important industrial significance. As director, Dr. Brown has developed a significant blending of fundamental research, professional engineering, and engineering education to the great strengthening of each. His activity has a strong motivating influence on both undergraduate and graduate students.

In 1948 Brown, with one of his students, Professor Donald P. Campbell, wrote a book entitled "Principles of Servomechanisms," which already has won a world-wide reputation.

As an example of his international standing, Dr. Brown was invited to give the opening address to the 1951 Conference on Automatic Control in Cranfield, England. His Servomechanisms Laboratory at M.I.T. has pioneered the development of education in this field and attracts many visitors and students from all over the world.

Errata

In the June issue of the *Journal of Engineering Education* Dr. Wada's name was incorrectly given as "Hiroshi" rather than "Koroku" in the article "The 1951 ASEE Engineering Education Mission to Japan" by Harold L. Hazen.

Secretary's Report
1951-52

This year the ASEE has completed a major project, which stands as a milestone in the accomplishments of the Society, while significant progress has been made on several other projects which are still on the road to completion. Several new projects have been launched during the year. It is the hope of the General Council and the Executive Board that these projects will be carried forth with the same vigor, inspiration, and discriminating judgment which has marked the significant contributions of the past, and that in time, they too will take their place among the clearly defined contributions to the advancement of engineering education.

Although these major projects are the focal point of effort and attention of the Society, they constitute a small portion of the total contribution of the Society to engineering education. Probably the greatest contribution of the Society is in its functioning as a national forum for the interchange of ideas and the unification of efforts of teachers and college administrators representing the many diverse fields bearing upon engineering education. Here, every conceivable phase of engineering education is subject to critical and constructive analysis and out of the cauldron of activity inevitably comes a clearer definition of the major issues and a logical and orderly approach to the solution of the problems. The vigorous activities of the members making up the Councils, Committees, Divisions, Sections, and Branches in this Society are the sources of its great strength and the hope for its future.

Committee on Improvement of Teaching

The report of the Committee on Improvement of Teaching, under the chairmanship of Dr. L. E. Grinter, brings to a close one of the major projects of the Society during the past three years. This comprehensive report presents a critical analysis of teaching objectives and methods. It places great stress upon the need for more successful teaching methods which will develop the student's latent abilities to do resourceful and creative thinking. It emphasizes the need for continued experimentation in educational methods toward the end of preparing the students to meet new situations with skill, resourcefulness, and leadership. It strongly emphasizes the desirability of teaching from basic laws and fundamental principles so that the students will gain a clear understanding of the scientific foundations underlying engineering. Copies of this report are available in any quantity from the headquarters office.

The Year of Evaluation

The rapidly advancing pattern of science and technology is confronting engineering education with numerous problems of broad scope and profound importance. The extension of knowledge of scientific fundamentals has opened doors to vast new areas of engineering endeavor and has greatly strengthened the foundation underlying many of our existing engineering fields. The question is constantly being raised as to whether or not our engineering curricula have sufficient depth and breadth of scientific foundation to enable the engineers of tomorrow to translate new scientific advances rapidly into engineering practice.

The Executive Board and General Council of the ASEE have given this matter careful consideration and have voted to undertake a critical analysis of engineer-

ing education with a view to clarifying the professional objectives and arriving at a clearer definition of the kind of engineering education which is necessary to assure maximum rate of progress of the engineering profession of the future.

A Committee on Evaluation of Engineering Education, under the chairmanship of Dr. L. E. Grinter, has been appointed to serve as a coordinating group for this study. It has been recommended that sub-committees be organized in the Divisions of the Society and in engineering colleges throughout the country and that these sub-committees study the foregoing and other problems related to engineering education and submit reports to the central committee. The recommendations of these sub-committees will then be consolidated into a unified report.

Cooperation between Engineering Colleges and Secondary Schools

A second project of the year has dealt with the development of closer working relationships between engineering colleges and secondary schools, with a view toward improving the educational background of students and also of developing closer liaison in matters relating to student guidance. This has arisen out of numerous expressions of concern among college educators over the inadequate preparation of students, particularly in the curricular areas of mathematics and the sciences. In the belief that this situation can be improved by concerted action, the Executive Board and General Council of the ASEE voted to develop this as a major project of the Society.

Significant progress has been made during the past year by the Sections of the Society, many of which have held conferences in which engineering educators and high school teachers and principals have presented their views. A number of engineering colleges are developing constructive, forward-looking programs in their local areas, in order to develop a common-ground interest between engineering educators and high school teachers. Several colleges are undertaking to offer specific courses for secondary school teachers in order to help them to understand more clearly the interrelationships between mathematics, physics, and engineering education.

The Fall meeting of the ECAC in Houston, Texas was devoted entirely to a program of cooperation between engineering colleges and secondary schools. Several excellent papers on the subject were also included in a conference of the Division of Relations with Industry in January. The Society has assembled these papers in a booklet "Developing Cooperative Relationships Between Engineering Colleges and Secondary Schools" which has been sent to the deans of engineering colleges and the Section chairmen.

Participation of Younger Faculty Members in ASEE Activities

One of the most promising developments during the past year has been that of lending increased emphasis to the stimulation of activities of younger faculty members in meetings and affairs of the Society. The younger faculty members have much to contribute to the constructive work of the Society, since they often have a vigorous, forward-looking approach to the problems of education. It is believed that they are a potent force which should be tapped and woven into the Society activities. Active participation in the affairs of the Society would enable the younger faculty members to gain a broader persepective of engineering education and it would help them to acquire effective teaching methods at a time when these tend to become crystalized.

Many of the Sections of the Society have given this problem serious consideration and are encouraging younger faculty members to take over responsible planning of part of the Section activities. The Executive Board is recommending that a national paper contest be undertaken by the Sections of the Society in order to stimulate participation of younger faculty members in the programs of the Sections. The Section winners of the paper contest

would then compete nationally for awards of the ASEE.

Teaching Aids Committee

The Committee on Teaching Aids has a number of reviewing committees actively engaged in reviewing and evaluating teaching aids for possible use in engineering instruction. A bulletin, listing acceptable teaching aids, giving details as to size, curricular use, availability, etc., will be published by the Committee. It is anticipated that publication will be completed next year. The Committee has carried on a highly successful fund-raising program and has obtained over $8500 in industrial contributions to carry forward the project.

Unity of the Profession

The recommendations of the Exploratory Group of the EJC on Unity of the Profession have been submitted to the participating societies for official action. These recommendations, centered around Plan A, provide for an enlarged EJC to include those qualified engineering organizations which have approved the plan. Assuming that a sufficient number of engineering societies approve the plan, a constitutional convention will be held to prepare a constitution for the new Unity organization. Although EJC is basically a council type of organization, it is still possible for the constitutional convention to revise the basic plan to provide for individual membership.

Mid-Year Meetings of Divisions of the ASEE

The Division of Relations with Industry held its mid-year meeting at MIT in January on the theme "The Student as an Individual." This meeting was attended by over 300 industrial representatives and faculty members.

The Engineering Drawing Division held its customary mid-year meeting in New York in January. The program included demonstrations of descriptive geometry as applied to ship building, photographic and color photographic processes, and a trip to Columbia University's cyclotron.

The Cooperative Engineering Division held its mid-year meeting at Northwestern University, the program consisting of a workshop discussion of the problems and policies of cooperative engineering education.

Publications of Divisions of the Society

In the past, perhaps all too little recognition has been given to some of the excellent work of the Divisions of the Society in the form of quarterly or semi-annual publications which contain technical papers in specific curricular areas. The Engineering Drawing Division was the first Division of the ASEE to establish its own bulletin. This has served a very constructive purpose in disseminating technical information on engineering drawing. The Civil Engineering Division for a number of years has published a quarterly bulletin, which contains technical papers in the diverse fields of civil engineering. The Machine Design bulletin, edited by the Machine Design Committee of the Mechanical Engineering Division is another outstanding example of a publication which is getting outstanding technical papers before the members of the Division. Each year, the Chemical Engineering Division prepares its Chemical Engineering Abstracts, representing papers presented at the Annual Meeting. The Southeast Section of the Society publishes its papers each year in a mimeographed volume, which is distributed to the members.

These bulletins are edited entirely by members of the Divisions and the cost of publication is offset either by including advertising of textbook publishers, or from the sale of the journals to the members.

ASEE Sponsored Summer Schools

This year, the ASEE sponsored four summer schools. The English Division, Electrical Engineering Division, and Civil Engineering Division (Sanitary Engineer-

ing) are all holding summer schools prior to the Annual Meeting at Dartmouth College. The ASEE also endorsed the Third National Surveying Teachers Conference, which was sponsored by the Civil Engineering Division and the University of Illinois. A unique summer school, sponsored by the ASEE, has been worked out jointly by the Committee on Improvement of Teaching and the General Electric Company. This program emphasizes teaching methods which develop originality and creative approaches in engineering.

Future Annual Meetings

The Annual Meetings for the next two years have been scheduled. The meeting in 1953 will be at the University of Florida and will be held on June 22–26. The University of Illinois will have the 1954 Annual Meeting.

New Committees

During the year, a Committee on Textile Engineering has been appointed, at the request of a number of faculty members and administrators in this field.

A Committee on Public Relations was appointed, under the chairmanship of Professor Schmelzer, during the year.

Associate Institutional Memberships

The industrial members of the ASEE have been a source of great vitality and strength in the operations of the Society. The Executive Board of the Society believes that increased participation of companies which have extensive engineering operations will inevitably accrue to the benefit of both industry and the educators. Consequently, a committee has been appointed under the chairmanship of Jesse McKeon to solicit Associate Institutional Memberships in the Society. This Committee is to be highly commended for its work, having obtained twenty-four new Associate Institutional Memberships during the past year alone.

Advertising in the Journal

The headquarters office of the Society is endeavoring to obtain new advertisers for the *Journal of Engineering Education* in order to expand this source of revenue. Preliminary results show that it should be possible to increase the advertising revenue significantly in the next few years. This will help to offset rising costs of operation, incurred by the continued expansion of Society activities.

Membership

Early in the year, a letter was sent to the deans of engineering colleges throughout the country, asking them to supply names of persons outside of the strictly engineering faculties who are actively teaching courses to engineering students. These included faculty members in mathematics, physics, and the social sciences and humanities. This request met with enthusiastic approval of the deans and over 500 letters of invitation to join were sent to faculty members proposed by the deans. This will result in a substantial strengthening of these Divisions of the Society. The total number of new members added this year is 520.

Participation in Activities of Other Societies

The Society has continued its active participation in many engineering and educational societies, including the Engineers' Council for Professional Development, the American Council on Education, the American Association for the Advancement of Science, the Educational Testing Service, the National Research Council, and the American Standards Association. Society representatives have been appointed to each of these organizations and in many cases the Society, through its representative, has contributed significantly to the work of the organizations.

Respectfully submitted,

A. B. Bronwell

Secretary

Minutes of Executive Board Meeting

A meeting of the Executive Board of the American Society for Engineering Education was held on Monday, June 23, 1952, at Dartmouth College, Hanover, New Hampshire. Those present were: S. C. Hollister, *President,* M. M. Boring, L. E. Grinter, J. H. Lampe, G. A. Rosselot, *Vice-Presidents,* C. L. Skelley, *Treasurer,* A. B. Bronwell, *Secretary,* C. E. Watson, *Assistant Secretary,* and B. Bowen.

Reports of Officers

Written reports of the Vice-Presidents and Secretary were discussed. A resume of these reports is given in the Minutes of the General Council meeting of June 23, 1952.

Treasurer's Report

The Treasurer presented the tentative annual audit to the Executive Board. The final audit (prepared subsequent to the Annual Meeting) shows a net excess of income over expense of $4268. The individual dues increased approximately $600 over the preceding year and the institutional dues increased approximately $1500. Advertising revenue was up approximately $1000. The expenses were in line with those of the preceding year, except for ECRC expense, which was considerably lower owing to a reduction in the ECRC publication program.

The income from sale of ECRC publications amounted to $3484.85. The Board discussed the transfer of funds to the ECRC reserve. According to a previous Executive Board ruling, the transfer to the ECRC reserve should include the unused budget of ECRC in addition to the income from sale of ECRC publications. The advisability of establishing a practice of transferring unused portions of the budget to a reserve for any particular group within the Society was questioned. However, it was recognized that the ECRC expenses fluctuate sharply, owing to the publication schedule of the particular year and that failure to establish an adequate reserve might subject the Society to a substantial deficit in a year when ECRC expenses are abnormally high. Accordingly, the Executive Board voted to transfer the unused portion of ECRC budget in addition to the ECRC income to the ECRC reserve for use in future years, with the understanding that this was not to be regarded as a precedent for future years.

The Executive Board also considered the general problem of supervision of expenditures of various groups within the Society. It was pointed out that the Divisions and Committees of the Society prepare a budget in May of each year for their anticipated expenditures during the following fiscal year. Aside from this budget, the Society headquarters does not at present maintain control over financial commitments of the Councils, Divisions and Committees, other than approval within the stipulated budget limits after the expenses have been incurred. In order to maintain closer supervision over financial commitments, the Executive Board voted that any item of expense exceeding $200 should first be approved by the Secretary's Office before financial commitment is made.

The budget for 1952–53 was approved, pending certain adjustments in income and increased secretarial staff salaries.

Report of Committee on General Council Activities

The Board discussed the report submitted by a Committee on General Council Activities, under the chairmanship of

Dean Barlow. This Committee was appointed to suggest means of enlarging the participation of the General Council in Society affairs. The report is summarized in the Minutes of the General Council meeting.

Society Organization

Consideration was given by the Executive Board to the problem of integrating the activities of the various Divisions, Sections, and Committees of the Society into an organic unit so as to improve the flow of ideas upward into the General Council and Executive Board and also so as to stimulate these groups to work on some of the overall problems of the Society. It was pointed out that the various Divisions, Committees, and Sections each operate in specialized areas and, although they may serve effectively in handling the problems in these restricted areas, they do not in general participate in some of the broader Society problems and policy matters.

Much of the basic policy of the Society originates in the Executive Board and flows downward into the General Council, where it is activated by the appointment of special committees. There is need for reversing this flow so that ideas originating in the Divisions and Sections will be encouraged to flow upward into the General Council where they can be activated. The Board recommended to the General Council that an ad hoc committee be appointed to study the Society organization and functioning and to make recommendations for improvements which will integrate the Society activities into a unified program.

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A meeting of new and old officers of the Executive Board of the American Society for Engineering Education was held on Wednesday, June 25, 1952, at Dartmouth College, Hanover, New Hampshire. Those present were: S. C. Hollister, *President,* M. M. Boring, L. E. Grinter, J. H. Lampe, G. A. Rosselot, C. L. Skelley, E. A. Walker, W. C. White, W. R. Woolrich, A. B. Bronwell, C. E. Watson, and B. Bowen.

Evaluation of Engineering Education

The plans for the program of the Committee on Evaluation of Engineering Education were discussed. The first meeting of the Committee was scheduled for the last day of the ASEE Annual Meeting at Dartmouth College. It was anticipated that the general problems and the method of attack would be formulated at that time and that the ASEE committee would request the deans of engineering colleges to appoint institutional committees to cooperate in this broad program.

Participation of Associate Institutional Members in Society Activities

The Board gave consideration to ways of developing a closer functional relationship between the Associate Institutional members and the activities of the Society as a whole. It was pointed out that the company representatives can play an active and influential role in the advancement of engineering education if they are acquainted with the objectives and philosophy of engineering education and if proper channels are provided for active participation in the Society. The highly successful activities of the Division of Relations with Industry have given impetus to the role which industry can take in working with engineering colleges in all phases of engineering education. Some concern was expressed over the possibility that industrial members of the Society might feel that they are superfluous in Society activities. This would deny the Society of a powerful and constructive influence which could render a great service to the Society. Accordingly, the Board recommended to the Council that an ad hoc committee consisting of Vice-President Boring and Mr. McKeon be appointed to study means of implementing increased participation of Associate members in activities of the Society.

Future Annual Meetings

President Hollister explained to the Board that subsequent to the time it re-

ceived the invitation from Cornell University, an invitation had been received from Pennsylvania State College inviting the Society to hold its 1955 Annual Meeting at State College, Pennsylvania. This would commemorate the 75th year of Pennsylvania State College. In view of the fact that Cornell had been host to the Society for three Annual Meetings and Pennsylvania State College had been host only once, and in view of the importance of the occasion, Dean Hollister stated that he was withdrawing the request for the Annual Meeting at Cornell University. No action was taken.

Bank Resolution

The Executive Board voted to authorize the President or Treasurer to co-sign checks with either the Secretary or Assistant Secretary, in accordance with previous practice.

Application of Ohio University for Active Institutional Membership

The application of Ohio University for Active Institutional Membership was presented. It was voted Active Institutional Membership by the Board.

Representative to UPADI

The Board voted to appoint Deans Steinberg and Lassalle as the official ASEE representatives to the meeting of the Pan American Congress UPADI to be held in New Orleans in August.

Insurance Plan

A plan which would provide for group disability insurance for members of the Society was briefly considered by the Board. The proposal was presented to Mr. Boring with a request that it be considered by some of the actuarial people in General Electric Company.

Expression of Appreciation from the President

The President of the Society expressed to the members of the Board his appreciation for the privilege of working with the Board on behalf of the Society during the past year, and expressed his grateful appreciation for the loyal cooperation and effective assistance which he had received.

Other Items of Business

Other items considered by the Executive Board on which actions are summarized in the Minutes of the General Council Meeting are:

1. Advertisements of teaching positions in Journal;
2. Unity of the Profession;
3. Continuation of program of cooperation between engineering colleges and secondary schools;
4. Participation of younger faculty members in activities of the Society;
5. Expansion of the Secretarial staff;
6. Society emblem;
7. Plans for Joint ASEE–ECPD meetings in Chicago.

Respectfully submitted,
ARTHUR B. BRONWELL
Secretary

College Notes

B. Richard Teare, Jr. has been appointed Associate Dean of the **Carnegie Institute of Technology** College of Engineering and Science. Dr. Teare will work closely with Dean Webster N. Jones in the general administration and policy planning of the College of Engineering and Science, including financial and educational development. The new Associate Dean is also Dean of Graduate Studies and Buhl Professor of Electrical Engineering.

Minutes of General Council Meeting

A meeting of the General Council of the American Society for Engineering Education was held on Monday, June 23, 1952, at Dartmouth College, Hanover, New Hampshire. Those present were: S. C. Hollister, *President;* M. M. Boring, L. E. Grinter, J. H. Lampe, G. A. Rosselot, *Vice-Presidents;* C. L. Skelley, *Treasurer;* A. B. Bronwell, *Secretary;* C. E. Watson, *Assistant Secretary;* H. P. Adams, Wm. Allan, H. H. Armsby, H. A. Bolz, C. A. Brown, M. P. Capp, W. H. Carson, D. S. Clark, F. M. Dawson, W. W. Dornberger (substituting for S. A. Smith), W. L. Everitt, C. J. Freund, D. M. Griffith, C. O. Harris, D. Hunt, L. Jones, Wm. P. Kimball, E. Laitala, E. J. Lindahl, K. B. McEachron, Jr., F. H. Miller, L. G. Miller, C. A. Mochmore, T. H. Morgan, E. F. Obert, R. S. Paffenbarger, G. K. Palsgrove, F. H. Pumphrey, J. C. Reed, J. H. Rushton, T. Saville, H. C. Spencer, L. O. Stewart, E. A. Walker, B. L. Wellman, K. Wendt, H. H. Wheaton, D. G. Wilson, S. Winston, W. R. Woolrich.

Reports of Officers

Written reports of the Vice-Presidents, Treasurer, and Secretary were presented, including a tentative annual audit and a budget for 1952–53.

Unity of the Profession

Dean Saville presented a recommendation that the ASEE formally approve the final plan proposed by the EJC's Exploratory Committee on Unity of the Profession. The Exploratory Committee recommended that the most feasible way to achieve unity was to adopt essentially Plan A, which would provide for a modification of the EJC structure to serve as a Unity organization. Dean Saville stated that the Executive Board of ASEE had recommended to the Council the endorsement of this plan and that in his opinion this would be the last opportunity for a number of years to come to form such a Unity organization. If it failed, there would probably be considerable adversity to any future attempts at the formation of such an organization. If the proposed plan is approved, a Constitutional Convention will be called to alter the EJC Constitution. Only those organizations signifying their approval would participate in drafting the Constitution.

It was voted that the ASEE signify to EJC its willingness to become a member of the EJC under approximately the provisions of Plan A if the invitation is extended.

Committee on Improvement of Teaching

Vice-President Grinter briefly reviewed the plan of operation of the Committee on Improvement of Teaching and the end results. He stated that approximately 1000 to 1500 people had been engaged in activities of this Committee on the institutional and national level. He recommended that the Committee be dissolved and that the activities be transferred on a permanent basis to the Division of Educational Methods.

Cooperation Between Engineering Colleges and Secondary Schools

Vice-President Boring reported on the work of the Sections in developing the program of cooperation between engineering colleges and secondary schools. This has been a joint undertaking of the Sections and the ECAC's Committee on Secondary Schools. He stated that a number of Sections have developed conferences with high school teachers and principals during the past year and that the results point to considerable potentiality for future development.

He also mentioned that the Engineering Manpower Commission of EJC has presented the story of the critical shortage of engineering manpower to 28,000 high school students throughout the country. Likewise, the Edison Foundation and the National Science Teacher's Association, which were established to promote interest in science and increase the flow of students into the scientific professions, have held conferences of officials in government, together with teachers in the engineering and science fields. These programs collectively have reversed the downward trend of engineering enrollments and produced a 15% increase in freshman engineering enrollment as compared with a 12% decline in all college enrollment.

Participation of Younger Faculty Members in ASEE Activities

The Secretary reported that the Executive Board has considered several programs for stimulating the activity of younger faculty members in the affairs of the Society. The Board recommended to the Council that a paper contest be inaugurated, to be developed by the Sections of the Society, as a means of enlisting the active participation of younger faculty members. The Board believes that as a consequence of an appeal through the President's Newsletter, most of the Sections of the Society are giving active consideration to developing conferences and programs where the younger faculty members manage the affairs and take the leading role. This program will have to develop primarily at the Section level, since for financial reasons, not many of the younger faculty members are able to attend the Annual Meetings of the Society.

The General Council voted to inaugurate a paper contest for younger faculty members on a broad subject to be announced by the President of the ASEE. Each Section would provide its own rules and would select the winning papers. These would be presented at the next Annual Meeting in June 1953. Awards of $200 and $100 each would be given for the two best papers presented by young faculty members.

A discussion of the age limit was not definitely settled, although it was tentatively agreed that the upper limits should be either 35 or 36 years of age.

Report of the Engineering Manpower Commission

Dr. Armsby reported that the Engineering Manpower Commission has presented testimony before Congress in connection with the Reserve Bill, in favor of placing the calling of reservists under a civilian agency rather than under the Department of Defense. It was believed that a civilian agency would be more discriminating as to the needs of the country for scientists and engineers than the military agencies.

Coordinating Committee on Relations with the Federal Government

Dean Saville reported on the work of the Coordinating Committee on Relations with the Federal Government. He urged that a closer liaison be established between the ASEE's Manpower Committee and the Engineering Manpower Commission of EJC, since no members of the ASEE committee have been on the Manpower Commisssion. He stated that the Manpower Committee, under the chairmanship of George Lobingier, has proposed that attention be given to immediate and satisfactory placement of engineering graduates who returning to civilian life after having completed their service duty.

Upon motion from Dean Saville, the Council voted to request the Executive Board to instruct Society representatives on the Engineering Manpower Commission of EJC to urge organization of a program in cooperation with the military services, industry, and the engineering colleges, to provide an adequate means for channelling engineers leaving military services into professional engineering positions.

Dean Saville also commented on the need for closer correlation of the ROTC policies of the three military services, par-

ticularly those of the Air Force, which is instituting a new ROTC program.

On resolution from Dean Saville, the Council voted to request the Executive Board to instruct the Society representatives on the American Council on Education to initiate appropriate action looking toward a better coordination of ROTC policies of the three military services and the implementation of joint policies looking toward improvements in existing practices relating to curricula, credits, teaching staff, and other elements of the ROTC programs.

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A meeting of old and new members of the General Council was held at Dartmouth College, Hanover, New Hampshire on Friday morning, June 27, 1952. Those present included: S. C. Hollister, *President;* M. M. Boring, L. E. Grinter, J. H. Lampe, G. A. Rosselot, *Vice-Presidents;* C. L. Skelley, *Treasurer;* A. B. Bronwell, *Secretary;* C. E. Watson, *Assistant Secretary;* Wm. Allan, H. H. Armsby, H. J. Barre, H. W. Barlow, H. R. Beatty, H. A. Bolz, M. P. Capp, W. H. Carson, D. S. Clark, F. M. Dawson, W. W. Dornberger (substituting for S. A. Smith), C. J. Freund, W. P. Godfrey, D. M. Griffith, C. O. Harris, D. Hunt, E. Hutchisson, H. Kuenzel, L. Jones, E. Laitala, E. J. Lindahl, J. C. McKeon, F. H. Miller, L. G. Miller, T. H. Morgan, C. Muhlenbruch, E. F. Obert, G. K. Palsgrove, O. H. Polk (substituting for R. S. Glasgow), J. C. Reed, N. F. Rode, J. H. Rushton, H. C. Spencer, L. O. Stewart, E. A. Walker, K. O. Werwath, C. L. Wilson, W. C. White, B. L. Wellman, K. Wendt, H. H. Wheaton, D. G. Wilson, S. E. Winston, W. R. Woolrich.

Fall Meetings of the ASEE–ECPD

The Secretary announced the plans for the joint ASEE–ECPD meetings to be held in conjunction with the Centennial of Engineering in Chicago on September 5–6. The ECRC conference on the theme "The Engineer is a Scientist" is scheduled for the morning of September 5, and the ECAC conference in the afternoon will deal with "What Are Contemporary Demands on Engineering Education." The ASEE and the ECPD will hold joint luncheons on Friday and Saturday and a dinner on Friday evening.

Technical Assistance Program

The Secretary reported on the January meeting of the Council on Economic and Social Development held in Washington. The purpose of the Council was to acquaint officers of learned societies and administrative officers of educational institutions with some of the objectives and problems of the government's technical assistance program. He stated that technical education at all levels is regarded as one of the important phases of the technical assistance program and that the ASEE could make a substantial contribution in helping to develop satisfactory technical educational programs in foreign countries.

Committee on International Relations

Dean Woolrich reported for the Committee on International Relations that a proposal had come from the State Department requesting assistance of the ASEE in handling policy matters relating to the placement of international exchange students in American industries for experience. The proposal came through the National Science Foundation and referred specifically to students from Great Britain. The students would pay their transportation, but attempts would be made to arrange for jobs in American industries for experience. In return, a number of American students would be permitted to visit Great Britain under a similar educational exchange program.

Expansion of the Office of the Secretary

The President announced the appointment of Professor C. E. Watson as Assistant Secretary on a part-time basis. Professor Watson has been handling editorial work for the Society and will also handle the solicitation of advertising for the Journal of Engineering Education.

Treasurer's Report

The report of the Treasurer relating to the annual audit is summarized in the Minutes of the Executive Board meeting. Subsequently, the final audit as of June 30, 1952 showed a net excess of income over expense of $4268 for the past year. This occurred after transferring $6004.69 to the ECRC reserve. The Executive Board approved the transfer, since the ECRC expenses fluctuate according to their publication schedule. The ECRC had no publications during the past year, but contemplated rather extensive publication schedule in future years. This transfer to the ECRC reserve enables the Research Council to smooth out its financial operations, so as to avoid a heavy drain on the Society finances in any one year.

The proposed budget for the next fiscal year was presented to the Council, and approved subject to certain changes.

The President stated that it was the policy of the Executive Board to provide for increased assistance in the Secretary's office so as to free a portion of the Secretary's time for important liaison work with other organizations and for furthering the development of Society projects. He stated that this would assure a more stable organization in the future. He expressed the opinion that the Society's affairs were in sound condition.

Report of the Vice-Presidents

Vice-President Grinter presented the written report on activities of the Divisions and Committees. He briefly discussed the Society organization and emphasized the need for bringing the Divisions and Committees into the forefront of the Society's activities in order to provide stimulus for continued progress. He stated that it was his hope that the Divisions can be brought into active participation in the study on Evaluation of Engineering Education which will be taking shape during the coming year. Dr. Grinter also announced that the Graduate Division had prepared a revision of the Manual of Graduate Study in engineering and that this would be completed in the near future.

Vice-President Boring reported on activities of the Sections and Branches of the Society. He recommended that a study be made of some of the geographical areas of the Sections, since it seemed that excessive travel distances discouraged attendance at Section meetings, particularly among the younger faculty members who could profit most by such participation. A general discussion from the Council members followed, in which it was pointed out that it might be well for the Sections themselves to propose a more effective plan of Section organization. The suggestion was made by Dean Wilson, Dr. Armsby, and Professor Pumphrey that a committee of the ASEE be appointed to study the problem in cooperation with the Section officers. No action was taken on this recommendation. It was also suggested that the present Sections had developed a substantial community of interest and pride in their regional activities. It might therefore be advisable to consider maintaining present Section autonomy with meetings once a year, but encourage educational institutions within a given local geographical area to develop ASEE programs within the framework of the present Section organization.

Vice-President Lampe presented a written report covering the work of the ECAC and its five committees. He reported on the success of the Houston meetings, centered on relations between engineering colleges and secondary schools in matters relating to the improvement of student preparation, guidance, and counseling. He stated that the ECAC was studying the transfer of credits from junior colleges to engineering schools. He reported on the session for Institutional representatives which dealt with administrative problems arising out of military affairs, salary trends, teaching loads, ROTC and NROTC programs, the satellite system which is developing between engineering colleges and liberal arts colleges, and the expansion of research activities. The Selection and Guidance Committee of the ECAC has as-

sisted the Educational Testing Service in the development of tests for the selection and guidance of students. Vice-President Lampe stated that a committee of the ECAC was currently studying teaching loads and salaries. He also pointed out that the ECAC has planned a conference with the Air Force ROTC officials to discuss curricular plans for the new Air Force ROTC program.

Vice-President Rosselot, reporting on the activities of the ECRC, stated that three new institutional members, St. Louis University, Lowell Institute, and Tulane University, were added to the ECRC during the past year. In reporting on the work of the Committee on Contract Relationships with the Government, he stated that considerable progress had been made toward getting recognition by government officials of the need for unified treatment of research contracts with engineering colleges. He reported that the ECRC general session program at the Annual Meeting dealt with the currently important problem of the impact of government operated and government sponsored laboratories on teaching and research.

Society Organization

The Report of the Committee on Activities of the General Council was presented to the Council. This report recommended that the Society should:

(1) Inaugurate at the Annual Meeting a general business meeting to present resolutions from Divisions, Committees, and Sections for consideration and discussion by the Society membership at large. The resolutions would be submitted to a Resolutions Committee for clarification and final drafting to avoid ambiguities. These resolutions, together with recommendations from the floor, would provide machinery for the flow of ideas from Sections, Divisions, Committees, and the general membership to the Council.

(2) Clarify the duties and responsibilities of members of the General Council.

(3) Present Governmental requests for engineering educators for special services to the Section representatives of the Council for recommendation in order to provide adequate geographical coverage.

(4) Improve the liaison between Council members and their Divisions and Sections by requiring that each Council member report at least once a year to his Section or Division on the activities of the Society and the Council; also that the Divisions and Sections be urged to use the Council member more fully by transmitting to the Council resolutions or proposals of the Section or Division.

(5) Establish a procedure whereby the Journal could serve as a clearing house to facilitate the exchange of graduate students with faculty standing.

(6) Establish in the Journal a section devoted to advertisement of teaching positions open.

(7) Recommend to the Sections and Divisions that only those members be considered for representation on the Council who will be able to attend Council meetings. It was suggested that either the current Section or Division chairmen or the retiring chairmen be considered for representation of the Division or Section on the Council

President Hollister stated that the Executive Board had given consideration to this problem of improving the Society organization. He pointed out that a number of Committees of the Society operate in the same areas as Divisions and that Sections of the Society have programs which cut across all of the Divisions and Committees. He stated that the Executive Board had authorized appointment of a Committee on the Improvement of Society Function with broader responsibilities than the Committee on General Council activities. This Committee will be composed of seven members under the chairmanship of B. R. Teare.

The Barlow report was accepted and items (3), (5), and (6) were referred to the Executive Board for action. The balance of the report was referred to the new Committee on Improvement of Society Function.

Teaching Position Advertisements in the Journal

One of the recommendations of the Barlow Committee report was that the Journal should carry advertisements of teaching positions. This was discussed at length by the Council. It was pointed out that this might have the immediate effect of placing lower salary bracket schools at a disadvantage. However, the long-range effect would be to tend to raise salaries in these schools. The Secretary reported that, with its present office staff, the Society could not serve as a clearing house and maintain personnel records. However, the Society can place blind ads in the Journal and relay replies to the particular institutions. It was the concensus of opinion that if ads were placed in the Journal they should be restricted to positions available in engineering colleges. The matter was referred to the Executive Board for further study.

Summer Schools

Mr. McEachron reported on the seminar of teaching methods which the General Electric Company sponsored during the week prior to the Annual Meeting. This was a joint undertaking by the Committee on Improvement of Teaching and the General Electric Company and was devoted to presenting teaching methods which develop originality and creative approaches in engineering. The Secretary also announced that ASEE summer schools in Electrical Engineering and Civil Engineering (Sanitary) had been held prior to the ASEE meeting at Dartmouth.

International Management Conference

Mr. McEachron reported that the International Management Conference would hold its next meeting at Delft and recommended that the Society appoint an official ASEE representative. The Council voted to authorize the Executive Board to make an appointment.

Relations with Industry Division Meeting with AAAS

Mr. McEachron reported that the Division on Relations with Industry had been approached by the AAAS to hold a joint meeting in St. Louis at the time of the Annual Meeting of the AAAS. The Council voted to approve such a meeting, subject to the wishes of the Division on Relations with Industry.

Associate Institutional Membership

Mr. McKeon presented a progress report on the Associate Institutional Membership drive. He reported that a pilot operation involving fifty companies had yielded twenty-four memberships and six additional commitments. He expressed the belief that a substantial number of companies will probably be interested in taking out institutional membership in the Society.

President Hollister emphasized the need for bringing industry and engineering education into a closer mutual relationship as respects the objectives of engineering education and also to provide a constructive program whereby Associate Institutional members will take a responsible role in the activities of the Society. He emphasized the need for close coordinated action on the part of teachers and industry in order to develop a sound approach to the advancement of engineering education. Dean Saville reinforced this point of view by stating that industrial men had proven unsuccessful on ECPD accreditation committees because they were not acquainted with the objectives and basic philosophy of engineering education and he hoped that by bringing engineers into more active participation in the Society, this would prepare them for responsibilities in accreditation work.

Reports of Committees

Constitution and By-Laws. Dr. Armsby presented the resolution of the Committee on Constitution and By-Laws to the effect that the Committee did not believe that the objectives of the Society can be improved

by hasty revision of the constitution, but rather that the problem should be studied carefully and that constitutional revision should be presented only when there is clear evidence of need. The Council voted to approve the resolution.

The Atomic Engineering Education Committee. Dr. Armsby stated that the Atomic Engineering Education Committee had been appointed two years previously and that the five regional committees had functioned very satisfactorily in developing regional programs on atomic engineering education. It was recommended that the committee be continued, but with a rotation of committee membership.

Teaching Aids Committee. Professor Muhlenbruch announced that the Committee on Teaching Aids is actively evaluating aids for use in engineering instruction and now needs the concerted assistance of faculty members throughout the country in supplying ideas of teaching aids which may be suitable for teaching purposes. He emphasized that the only way in which the committee can learn about available teaching aids is to have them brought to their attention by various faculty members.

Emblem for the Society

The emblem recommended by the Executive Board for the flag to be flown at the Centennial of Engineering and for tentative adoption of the Society was discussed and approved. This had been prepared by Professor Blakeslee at the University of Detroit. It was understood that this constituted tentative approval and that the General Council could revise this emblem in the future if it deemed such action desirable.

Resolutions of the Technical Institute Division

President Werwath read two resolutions of the Technical Institute Division. The first emphasized the critical shortage of engineers and technicians and the general lack of understanding on the part of the public and educators concerning the place of the technician, owing to inconsistent terminology. It therefore recommended that, in the interest of clarity and public understanding of the nature of the technical institute training and the place of the technician in industry, members of the ASEE be urged to refer to graduates of technical institutes as *engineering technicians.* It also advocated an *associate degree* as an appropriate title of accomplishment to distinguish from the baccalaureate degree granted by engineering colleges. It was recommended that the resolution be referred to a committee of the General Council with the request that a report be prepared to be submitted to the Society as a whole.

The second resolution of the Technical Institute Division proposed that the ASEE recommend to the Department of Defense the establishment in approved technical institutes of a Reserve Technical Training Corps. The Council voted to refer this resolution to the ASEE representatives on the Engineering Manpower Commission of the EJC. Dean Saville further suggested that these two proposals, along with the proposals of the Coordinating Committee on Relations with the Federal Government be referred to the Engineering Manpower Commission and the American Council on Education. The Council approved the motion.

In closing the meeting, President Hollister mentioned the death of three distinguished past presidents, Dugald C. Jackson, Fred E. Turneaure, and Charles E. MacQuigg. The following resolutions extending the sympathy of the Society to the families were voted by the Council. The Council also passed a resolution of greetings to Dean H. P. Hammond, who was unable to attend because of illness.

Tribute to Dugald C. Jackson

At the 60th Annual Meeting of the American Society for Engineering Education held at Dartmouth College in June 1952, the General Council of the American Society for Engineering Education unanimously voted the following tribute to its eminent past president and distinguished educator.

The American Society for Engineering Education desires at this time to express to Mrs. D. C. Jackson and her family its deepest sympathy on the passing of their beloved husband and father, Dugald C. Jackson. Dr. Jackson was held in high esteem by all who were privileged to know him. He was a man of high ideals and great breadth of vision who understood the relation between education, industry, and government. He was a leader in intellectual thought and a vigorous champion of the advancement of the professions of engineering and education. Practically every major engineering society can claim Dugald C. Jackson as a distinguished contributor to their progress, but the American Society for Engineering Education takes pride in claiming him as its distinguished past president and as one of the truly great men who built the Society to its present high stature. Seldom is it given in the lifetime of man the privilege of associating with a man of the vision and ability to translate ideas into action for the progress of humanity which Dr. Jackson possessed. Therefore, in humble tribute, the American Society for Engineering Education wishes to extend its greetings to Mrs. Jackson and to her family, with the clear recognition that the work of Dugald C. Jackson and his influence have created a permanent and growing memorial far beyond the ability to express in words.

Tribute to Charles E. MacQuigg

At the 60th Annual Meeting of the American Society for Engineering Education, held at Dartmouth College in June 1952, the General Council for the American Society for Engineering Education unanimously voted the following tribute to its distinguished past president.

The American Society for Engineering Education wishes to extend to Mrs. Charles E. MacQuigg and her family their deepest sympathy on the passing of their beloved husband and father. To the members of the American Society for Engineering Education and to all who had the privilege of associating with him, Dean MacQuigg was held in high esteem as a great humanitarian and a man of depth of vision and understanding of human problems. He was ever humble and self-effacing but his vision and broad perspective exerted a profound influence throughout the entire educational fraternity, as well as in local, state, and federal governments. His untiring devotion in guiding his own institution, Ohio State University, into a position of leadership among engineering colleges and his active participation throughout many phases of the work of the American Society for Engineering Education, and as its distinguished president in 1947 have earned him the high respect and esteem of engineers and educators throughout the country. His widespread influence in the engineering and educational professions, in the local, state and federal governments, as well as his great humanitarian interests, are an enduring tribute to a truly great man.

Tribute to Frederick Turneaure

At the 60th Annual Meeting of the American Society for Engineering Education held at Dartmouth College in June 1952, the General Council of the American Society for Engineering Education unanimously voted the following tribute to Frederick Turneaure, a distinguished past president of the Society and a great engineering educator.

The American Society for Engineering Education wishes to express to the family of Dean Frederick Turneaure its deepest sympathy on his passing. Dean Turneaure was an eminent engineer and a truly great educator. He was a relentless worker for the advancement of the engineering and educational professions. His depth of in-

sight and broad perspective of the trends of engineering education were clearly evident in his presidential address when he became the distinguished president of the Society for Promotion of Engineering Education. Dean Turneaure was held in high esteem by all who were privileged to associate with him. His untiring work contributed profoundly to the building of this Society to its present high stature. Throughout the educational and engineering professions Dean Turneaure's influence has built an enduring memorial, a tribute to a great man.

Respectfully submitted,
ARTHUR B. BRONWELL,
Secretary

Sections and Branches

The **Ohio Section** held its annual meeting at the Ohio State University on May 3, 1952. The meeting was opened by S. M. Marco. F. W. Heimberger and E. E. Dreese welcomed the members to the campus.

The morning session was devoted to discussions on counselling high school graduates to enter engineering. G. B. Earnest presided. The first speaker was R. D. Landon. He discussed the various information bulletins he has prepared and sent out to high schools in the northern part of Ohio. He then introduced his guest, O. L. Schneyer, who gave a few remarks on "What Colleges Can Do to Help the High Schools." The next speaker was J. G. Odgers, Jr.

The afternoon session started with a report by R. T. Howe on the Objectives of Young Engineering Teachers Committee. E. W. Weaver reported on the activities of this committee at the University of Toledo.

The following slate of officers was nominated and unanimously approved: Chairman, H. K. Justice; Vice-Chairmen, E. O. Scott and N. D. Thomas; Secretary, K. F. Sibila.

H. K. Justice presided at the regular afternoon session which had as its theme, "Counseling Superior Students to Enter Graduate Work." L. G. Mitten and R. J. Anderson were the speakers.

The **National Capital Area Section** of the American Society for Engineering Education held its 1952 Annual Meeting on May 10, 1952 at The George Washington University, Washington, D. C.

The topic for the morning session was "What Can the Secondary Schools Do to Help in the Training of Engineers." Chairman William Oncken, Jr., presented the panel of five speakers whose names are as follows: W. T. Read, Harold A. Haynes, Charles E. Bish, Wilbur Jones, and Marian Magruder.

The afternoon session consisted of discussion on the topic: "Trends in Engineering Education," following a paper by Robert Roy, Assistant Dean of Engineering, The Johns Hopkins University, on the subject "The Hopkins Plan."

The following officers were elected for the year 1952–53: *Chairman:* L. K. Downing. *Vice-Chairman:* C. H. Walther. *Secretary-Treasurer:* Dugald C. Jackson, Jr. *Council Representative:* Two year term: H. H. Armsby.

New Members

AUZENNE, GUSTAV, Chairman and Associate Professor of Business Administration, Howard University, Washington, D. C. S. S. Davis, L. K. Downing.

BELL, JAMES W., Placement Director and Assistant Professor of Engineering, Lowell Textile Institute, Lowell, Mass. M. E. Gelinas, M. Hindle.

BERGER, J. ALFRED, Acting Head and Associate Professor, Department of Metallurgical Engineering, University of Pittsburgh, Pittsburgh, Pa. R. C. Gorham, P. E. Rush.

BERNINGHAUSEN, DAVID K., Librarian, The Cooper Union, New York, N. Y. C. H. Young, K. E. Lofgren.

BIGGERSTAFF, JOHN S., Instructor in Mathematics, Drexel Institute of Technology, Philadelphia, Pa. F. H. M. Williams, D. Dowell.

BILYK, MATTHEW H., Assistant Professor of Machine Design, Stevens Institute of Technology, Hoboken, N. J. M. R. Reeks, N. J. Rose.

BUDY, JOSEPH J., Instructor in Electrical Engineering, Milwaukee School of Engineering, Milwaukee, Wis. F. J. Van Zeeland, F. Kaufmann.

BURNS, F. J., Associate Professor of Mechanical Engineering, Newark College of Engineering, Newark, N. J. J. L. Polaner, P. Mainardi.

CHURCHILL, STUART W., Instructor in Chemical and Metallurgical Engineering, University of Michigan, Ann Arbor, Mich. E. H. Young, R. C. Walker.

DAVIDSON, ROBERT F., Assistant Professor and Chairman, Mechanics Dept., Missouri School of Mines, Rolla, Mo. R. A. Schaefer, J. W. Rittenhouse.

DE WILDE, ANDRIES C., Instructor in Engineering, Detroit Institute of Technology, Detroit, Mich. L. L. Henry, E. A. Lucitte.

DOERINGER, CHARLES E., Lecturer in Electrical Engineering, University of Toronto, Toronto, Ont., Canada. L. S. Lauchland, G. E. Tracy.

DOWNING, REGINALD H., Dean, Resident College, USAF Institute of Technology, Dayton, Ohio. J. H. Belknap, H. P. Hammond.

ELIAS, EDWARD M., Instructor in Engineering Extension, Pennsylvania State College Center, York, Pa. K. L. Holderman, V. E. Neilly.

ERDMAN, FREDERICK S., Professor of Heat Power, Cornell University, Ithaca, N. Y. D. Dropkin, C. O. Mackey.

ESPELIE, ERNEST M., Assistant Professor, Library, U. S. Coast Guard Academy, New London, Conn. S. C. Hollister, R. Werry.

FAVILLE, JOHN, JR., Director, Field Service, Milwaukee School of Engineering, Milwaukee, Wis. H. M. Wermath, F. Kaufmann.

FAY, JAMES A., Assistant Professor of Engineering Mechanics, Cornell University, Ithaca, N. Y. D. F. Gunder, H. C. Perkins.

FITZGERALD, JOSEPH M., Instructor in Chemistry, Newark College of Engineering, Newark, N. J. D. W. Dickey, T. J. Tully.

FOODY, JOHN J., Professor and Head of Engineering, State University Maritime College, Fort Schuyler, Bronx 61, N. Y. C. H. Young, K. E. Lofgren.

GRIMM, C. JAMES, Assistant Professor of Electrical Engineering, Missouri School of Mines, Rolla, Mo. I. H. Lovett, J. W. Rittenhouse.

HARTFORD, ARTHUR F., Supervisor, Employee Relations, E. I. du Pont de Nemours Company, Wilmington, Dela. S. L. Scott, D. W. Durham.

HILL, CLAYTON B., JR., Placement Representative, Employee Relations Dept., E. I. du Pont de Nemours Company, Wilmington, Dela. D. W. Durham, S. L. Scott.

HILTON, HARRY H., Assistant Professor of Aeronautical Engineering, University of Illinois, Urbana, Ill. H. S. Stillwell, J. M. Coan, Jr.

HOOPER, IRVIN P., Associate Professor of Mechanical Engineering, Rose Polytechnic Institute, Terre Haute, Ind. H. A. Moench, C. C. Knipmayer.

HULLEY, OLIVER S., Associate Professor of Industrial Engineering, Purdue University, Lafayette, Ind. H. A. Bolz, H. F. Owen.

ILIO, DOMINADOR I., Assistant Professor of Mechanics, University of the Philippines, Quezon City, P. I. C. J. Posey, J. W. Howe.

KAYS, WILLIAM M., Assistant Professor of Mechanical Engineering, Stanford University, Stanford, Calif. A. L. London, L. S. Jacobsen.

KELLER, EDWARD L., Assistant Director of General Extension, Pennsylvania State College, State College, Pa. K. L. Holderman, V. E. Neilly.

KENNEDY, OWEN W., Assistant Professor of Electrical Engineering, Worcester Polytechnic Institute, Worcester, Mass. T. H. Morgan, D. E. Howes.

KERR, LEWIS W., Instructor, Automotive Dept., Franklin Technical Institute, Boston, Mass. B. K. Thorogood, R. G. Adams.

KLEIN, KURT K., Design Engineer with J. N. De Serio, Consulting Engineer, Buffalo, N. Y. C. M. Fogel, H. M. Gehman.

KRACKHARDT, RUSSELL H., Assistant Professor of Electrical Engineering, Worcester Polytechnic Institute; Worcester, Mass. T. H. Morgan, H. H. Newell.

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KRUEGER, JOHN F., Assistant Professor of General Engineering, Purdue University, Lafayette, Ind. R. W. Lindley, H. A. Bolz.

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MARSH, ROBERT F., Assistant Professor of Electrical Engineering, Norwich University, Northfield, Vt. W. D. Emerson, R. W. Thieme.

MCEACHRON, KARL B., Manager, Laboratory-Engineering Dept., General Electric Company, Pittsfield, Mass. M. M. Boring, A. Haertlein.

MCGEADY, LEON J., Assistant Professor of Metallurgy, Lafayette College, Easton, Pa. W. B. Plank, E. L. McMillen.

MCKEAN, A. K. F., Associate Professor of Social Studies, North Carolina State College, Raleigh, N. C. K. O. Beatty, R. Hazelton.

MENAND, HOWARD, JR., Lecturer in Mechanical Engineering, Princeton University, Princeton, N. J. J. C. Elgin, K. H. Condit.

MENKE, EUGENE M., Assistant Professor of Electrical Engineering, Union College, Schenectady, N. Y. J. B. Morrison, G. S. Smith.

MILES, AARON J., Professor and Chairman, Mechanical Engineering, Missouri School of Mines, Rolla, Mo. E. W. Carlton, R. H. Young.

MILLER, EARL A., Assistant Professor of Electrical Engineering, Virginia Military Institute, Lexington, Va. J. S. Jamison, Jr., R. J. Trinkle.

MILLER, K. S., Assistant Professor of Mathematics, New York University, New York, N. Y. H. A. Giddings, I. Wladaver.

MINFORD, WALDO E., Instructor in Electrical Engineering, University of Nebraska, Lincoln, Neb. F. W. Norris, O. E. Edison.

MOORE, GEORGE E., Manager, University Relations, Westinghouse Electric Corporation, East Pittsburgh, Pa. J. C. McKeon, G. D. Lobingier.

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NAU, ROBERT H., Assistant Professor of Electrical Engineering, University of Illinois, Urbana, Ill. J. V. Neal, P. K. Hudson.

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PETERS, ARTHUR S., Professor of Mathematics, New York University, New York, N. Y. H. A. Giddings, G. A. Yanosik.

PIPES, LOUIS A., Professor of Engineering, University of California, Los Angeles, Calif. A. B. Bronwell, S. C. Hollister.

QUICK, FLOYD J., Instructor in Chemistry-Physics, Fresno Junior College, Fresno, Calif. J. B. Franzini, A. B. Bronwell.

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RUNG, THOMAS J., In Charge Terminal Study, Pennsylvania State College, State College, Pa. K. L. Holderman, K. Hunter.

RUSSELL, JOHN B., Professor of Electrical Engineering, Columbia University, New York, N. Y. J. M. Garrelts, J. R. Ragazzini.

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WHITSON, LEE S., Professor of Industrial Engineering, University of Minnesota, Minneapolis, Minn. A. M. Severson, J. M. MacKenzie.

YAMAUCHI, YOHIKAZU W., Assistant in Mechanical Engineering, University of Detroit, Detroit, Mich. H. Gudebski, W. P. Godfrey.

YODER, ELDON J., Research Engineer, Civil Engineering Department, Purdue University, Lafayette, Ind. K. B. Woods, E. C. Thoma.

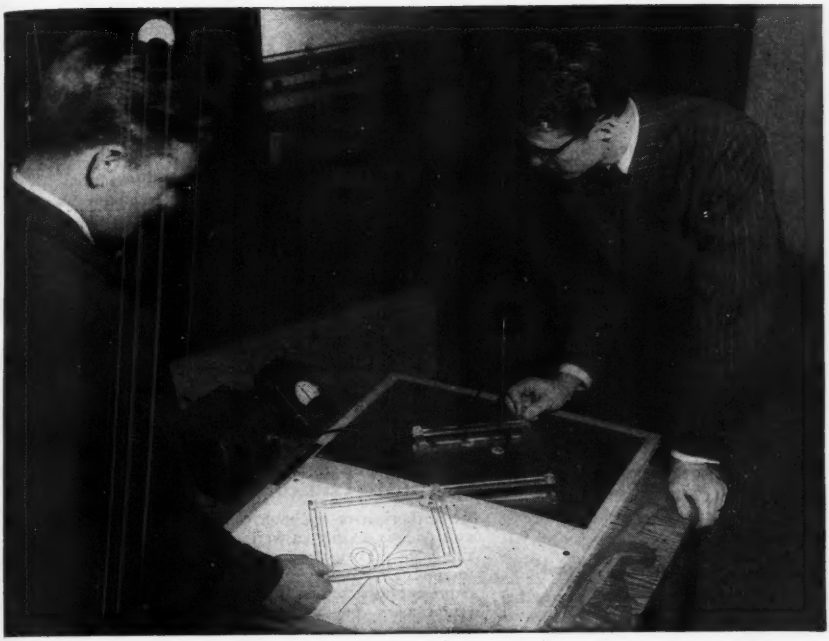
ZINN, ROBERT E., Professional Lecturer, Chemical Engineering, Northwestern University, Evanston, Ill. L. F. Stutzman, G. G. Lamb.

78 new members elected this year

College Notes

The appointment of Gordon S. Brown as head of the Department of Electrical Engineering at the **Massachusetts Institute of Technology** was announced by Dr. James R. Killian, Jr., President of the Institute. Dr. Brown, who assumed his new duties on July 1, succeeded Dr. Harold L. Hazen, whose appointment as Dean of the Graduate School was announced recently .

Everard M. Williams, voted the outstanding young electrical engineer of the United States in 1946, has been appointed Head of the Department of Electrical Engineering at **Carnegie Institute of Technology.** Designer of the oscillator and deflector for the Carnegie Tech 2½ million dollar synchro-cyclotron, Dr. Williams has been a member of the Carnegie faculty since 1945.



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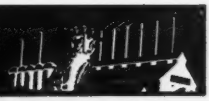

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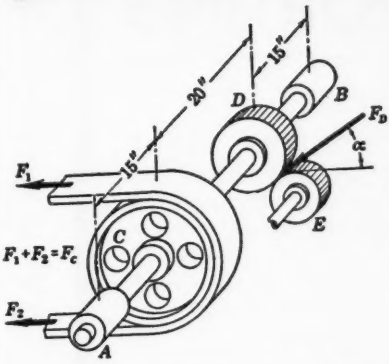

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